TOPICS OF THE MONTH

The chemical industry and chemical engineering research

THE Association of British Chemical Manufacturers along with the British Chemical Plant Manufacturers Association have decided against the setting up of any central form of chemical engineering research organisation at present. It was decided that immediate support for such an organisation would not be sufficient and that of highest priority was the need for setting up an advisory service to stimulate a proper appreciation of the economic advantages of applying chemical engineering knowledge. A research committee was also needed to study the chemical engineering requirements of the industry and, in cases where gaps in knowledge were established, to propose steps by which appropriate research might be carried out.

The Council of the A.B.C.M. have accordingly decided to set up a chemical engineering research and advisory committee which will include a liaison member nominated by the B.C.P.M.A. and will be served by a full-time executive officer.

These decisions are the outcome of the discussions that have been taking place between the two associations and which have their origin in the Cremer Committee's report, published four years ago. Announcing the conclusion of these discussions at the A.B.C.M.'s annual general meeting, the chairman, Mr. W. J. Worboys, revealed that in the analysis leading to this conclusion it was felt that the main requirements of the industry in this matter were that:

(*a*) Published chemical engineering knowledge and data should be readily available in as compact a form as possible.

(*b*) Fundamental work on the basic factors controlling operations which are or are likely to be widely used in chemical processes should be encouraged.

(*c*) There should be available in the United Kingdom the means by which chemical manufacturers and chemical plant manufacturers, irrespective of their size, can arrange for research to be done on specific chemical engineering problems arising in connection with the development of new or improved chemical processes and plant, *e.g.* an institution in which experimental work could be sponsored and paid for by the party requiring it to be done.

(*d*) There should be available means by which those producers of chemicals or chemical plant who do not possess chemical engineering research facilities or the appropriate technical staff can be assisted in their appreciation of the advantages to be gained from the application of existing chemical engineering knowledge and given advice on how to solve their chemical engineering problems.

The type of research referred to in (*b*) can be and is being done in the universities. The type referred to in (*c*) requires fairly close contact betweeen the researchers, plant designers, plant operators and those who will ultimately sell the product of the plant. It is being done now on a not unsubstantial scale by larger firms, by some of the nationalised undertakings and by a number of research associations.

Broadly, the functions of the committee will be to consider the chemical engineering requirements of the British chemical industry and to recommend from time to time steps which might be taken to extend chemical engineering knowledge; it will also endeavour to ensure within member firms the appreciation of the benefits that can accrue from the application of chemical engineering knowledge.

The work of the committee and advisory service will doubtless disclose the need for some addition to the present national facilities for research in this field.

Terramycin production in Britain

WITH a new £2½-million fermentation plant which has been opened at Sandwich, Kent, Pfizer Ltd. bring to Britain for the first time the complete manufacture of the broad-spectrum antibiotic, *Terramycin*. The plant uses the deep-fermentation method of producing antibiotics, first introduced by Pfizer's during the war to meet the heavy demand for penicillin. This method has proved so successful that Pfizer's are now reputed to be the world's largest producers of antibiotics.

Terramycin has previously been imported from the United States and undoubtedly the Sandwich plant represents a considerable addition to antibiotics manufacturing facilities in Britain. One has only to consider the cost of the plant to visualise the large amount of chemical engineering plant, equipment and skill that have gone into it.

An illustrated description of the plant will appear in our next issue.

Gas from oil

AN agreement has been signed by British Petroleum and the South Eastern Gas Board for the production of town gas from oil in a plant to be erected by the Board at B.P.'s Kent oil refinery on the Isle of Grain. The new plant will be the first in the United Kingdom to use oil products on a large scale as the only material for gas production, and it may prove to be significant as the point of departure from the long tradition of the gas industry in relying on coal as its main raw material.

In the first stage, gas will be produced on the scale of 15 to 20 million cu.ft./day, with a saving of about 300,000 tons of coal p.a. The quantity of oil to be used in the first stage is estimated to be 60,000 to 70,000 tons p.a.

Magnetite from low-grade ores

A METHOD of producing premium-grade feed for blast furnaces from formerly useless ores has been developed in the United States. It is now possible to convert low-grade hematite ores into magnetite—the magnetic form of iron oxide—by an economical fluidising process. The magnetite can then be refined by a magnetic separation method.

This conversion has long been considered a possible method of making use of otherwise worthless ore deposits and now, as a result of ten years of test work, the step seems feasible because of the application of the fluidising technique. It is stated that most low-grade ores are amenable to the process and, in most cases, the iron recovery is over 90%.

The fluidising process, which is carried out at high temperature, consists of bubbling a gas rapidly up through a bed of the hematite ore, ground to a fine powder. The gas takes away some of the oxygen of the ore, reducing it to the magnetite form. It is stated that the process is continuous, can deal with large quantities of ore, is virtually automatic, can be controlled to give a uniform high-quality product and is an unusually flexible operation.

The cheapest gas available for use with the Great Lakes ores at present is producer gas made from bituminous coal and, for this reason, the test work was conducted with this gas. The tests show that good results can be achieved in a small-scale fluidising reactor followed by magnetic separation. The next step in the development of this system will be the installation of a prototype unit in co-operation with an iron-ore producer.

The ore flows by gravity through the system, once it is conveyed to the top of the reactor, overflowing from one compartment to the next much like water. No 'slippage' or 'hang up' occur to upset the operating conditions.

The new development was reported at the 128th national meeting of the American Chemical Society, held in September, by Mr. R. J. Priestley, a chemical engineer of Dorr-Oliver Inc. He also presented an estimate of the operating costs for processing 1 long ton of feed in a fluidising unit 22 ft. in diameter and 70-ft. high. Starting with a coal for making producer gas, the cost was 71 cents. With natural gas it was 63 cents.

New basic materials wanted

DIMINISHING world resources of basic materials such as iron and copper, and the urgent need for research to combat this problem, was referred to by Sir George H. Nelson in his presidential address to the Institution of Electrical Engineers in London last month. He pointed out that progress in raising the world's standard of living might make the problem an acute one in 100 years' time. One hundred years is a very short period, in normal times, in which to solve problems of such immense and fundamental character as producing appropriate artificial substitutes and/or producing synthetically basic metals in quantities as the result of recent research into transmutation or synthesis of a heavy element from a lighter one.

Prominent in the field of production of artificial substitutes, he pointed out, are the cellulose products. The possibilities in this direction could be measured by considering the immense quantities of solar energy which reached us from the sun; it is this solar energy which provides the base of cellulose pulp. On the subject of *Terylene* fibres, Sir George pointed out that these have physical properties comparable with steel, which indicates that in time means may be found of economically producing materials in suitable forms as a substitute for steel for structural purposes, making it possible to conserve the use of iron ore to make steel for its magnetic or other special properties.

Fission products in chemical manufacture

FIGURES based on four years of experimental work at the University of Michigan indicate that the commercial production costs for a number of industrial chemicals are likely to be considerably cheaper than existing production costs when the radiation from radioactive fission products is used instead of other manufacturing processes. The experiments, in which radioactive cobalt 60 was used as a substitute gamma ray emitter in place of the fission products which were not available in the U.S., have involved the testing of the reaction-promoting characteristics of such radiation for a number of different types of industrial chemical processes. This has been done on a scale sufficient to enable the qualities of the manufactured product to be tested as well as the effectiveness of the technique in speeding up the manufacturing process.

In some cases, also, further work on the costing of production on a commercial scale by means of the use of radiation from fission product sources, which will be available in the near future (some fission product sources are already available and in use in Britain), has been undertaken. Details of one such cost of production process calculation show, for example, that 131,500 kg. (12.9 tons) of gamma benzene hexachloride, an extremely powerful insecticide, could be manufactured per year at a total cost of $218,000, if the cost of the fission product source, caesium 137, was charged at $5 per curie of radioactivity emitted.

These figures have recently been the subject of comment in the *Financial Times*, whose scientific correspondent points out that this cost is equivalent to $1.66/kg. for a 12% mixture of this form of benzene hexachloride in other non-insecticidal forms of benzene hexachloride, which compares favourably with the current U.S. price of from $1.9 to $3/kg. for equivalent mixtures made by normal commercial methods.

What are the prospects for the manufacture of heavy chemicals using radiation from fission products? This subject was touched on in a paper presented at a London meeting of the Society of Chemical Industry by J. Wright, B.A., of the Atomic Energy Research Establishment, Harwell, earlier this year. Calculations show that the quantity of chemicals that could be

produced in this way is quite large compared with the output of certain pharmaceutical products, but quite insignificant where heavy chemicals are concerned. Taking phenol as an example, the total yield of this chemical from the total output of fission products from the nuclear power industry in 1965 would be only some 5,000 tons p.a., assuming continuous operation and 100% efficiency in the use of radiation. This is only about half of the production of 'natural' phenol in Britain. It does not seem likely that radiation will ever be used for the production of the major heavy chemicals unless the radiation is used to initiate a chain reaction.

Sulphur from surface ores

WHAT is claimed to be the first commercially practical operation for extracting sulphur from surface ores has been launched by the Continental Sulphur & Phosphate Corporation's new $1½-million mill at Sulphurdale, Utah. The mill will produce 99.7% pure sulphur, which commands a price of about $85/ton against $45 for common brimstone sulphur, normally produced from underground deposits.

While there are millions of tons of sulphur surface deposits in the U.S., it has hitherto proved more profitable to extract the element from underground deposits. Continental Sulphur is using an extraction process developed and patented by the Esso Research & Engineering Co., a subsidiary of the Standard Oil Co. of New Jersey. It plans eventually to raise the output of the Sulphurdale mill from 100 to 500 tons/day.

However, things are by no means standing still in the world of sulphur production by more conventional methods, for the discovery of a major sulphur deposit six miles off Grand Isle on the Louisiana coast has also been reported, and is claimed to rank among the three or four top sulphur discoveries in the world. It is a very rich layer, over 200-ft. thick and extending over a few hundred acres. A rough estimate puts the deposit at 30 or 40 million tons of sulphur. The Humble Oil & Refining Co. made the find while hunting for oil in the Gulf of Mexico. The company are considering building a plant or co-operating with other sulphur producers to mine the mineral from the Gulf, making it the first offshore sulphur operation of its kind in the country.

Comical Engineering Terms

"MECHANICAL SEALS"

Plant, Materials, etc.: A New Illustrated Feature and Free Service for C.P.E. Readers

IN these days of fierce competition and rising costs, no engineer or manager can afford to miss anything in the way of new plant, equipment, materials, processes, etc., which might help to increase the efficiency of his undertaking. Nor can he afford to waste time addressing innumerable enquiries to possible suppliers of such items. There is a need for a service which will summarise for him those items likely to be of interest and also provide him with a means of obtaining further information about them quickly and without bother.

With this issue of CHEMICAL & PROCESS ENGINEERING *we introduce just such a service for our readers. The special illustrated section on pages 401 to 408 includes a report on recent developments, and associated with this are business reply postcards. To obtain further information about any items which interest him, the reader simply fills in a card and pops it in the post. Our Enquiry Bureau does the rest.*

We feel sure that many busy executives will welcome this new service, which is provided free of charge, and that they will make good use of the reply-paid postcards provided.

Fats from bones by new process

SUBSTANTIAL claims have been made for a new process of extracting fats from bones. Raw bones, of which some 160,000 tons p.a. are used in England alone, are a valuable source of several important products, including fats, glues, fertilisers and animal feeding meals. Degreasing and sterilising is usually achieved by the solvent fat extraction process where a benzene solvent is heated by high-pressure steam. This century-old process is the method adopted by the majority of manufacturers.

The new process has been developed by Sheppy Glue & Chemical Works Ltd. and marks a complete breakaway from the conventional method. A major discovery by the inventor of the process, Dr. E. M. Vyner, a director of the firm, was that under certain conditions prevailing during the pretreatment of the raw material, fat contained in bone cells can be set free and separated by thermo-mechanical means after

the bones have been crushed to the required size. The entire operation, from the loading of bones (the by-products of meat canning factories, slaughter-houses, butchers, etc.) on to a moving-belt conveyor feeding the pretreater to the separation of the released fats, feeding stuffs and substantially degreased bones, is automatic and semi-continuous.

The total time required for the raw material to be rendered in its final form is approximately 30 min. For an equivalent batch by conventional methods, the required processing time would be up to 40 hr. It is also claimed that certain disadvantages, such as contamination by solvents in the finished products, are absent in the new process. Savings in steam and electricity are in the region of 85 and 50%, respectively. Labour savings, as compared with the orthodox degreasing method, are also very substantial.

It is possible, the company say, to obtain almost 100% recovery from the starting material. One of the claims for this process is that better yields are obtained of higher-quality products. The proposed design of the plant was vetted by the Work Study School at Cranfield, Bucks, and approved without reservation.

Research has been carried out since 1948 under the direction of Dr. Vyner. Full-scale production started in July. All the building work and most of the plant fabrication was carried out by the company's own employees. A day shift of seven (four men and three women) work in an almost dairy-like atmosphere—in contrast to the unpleasant conditions which up to now have been associated with the industry. The old plant will probably be utilised for other purposes, and at a later stage may be completely closed down.

According to a recent issue of *Target*, in which the new process has been discussed, no redundancy of labour will be experienced as a result of the new process, as an increase in production in the other departments of the firm is anticipated in which labour can be absorbed.

New road for waste chemicals in Hungary

EXPERIMENTS are being carried out by a research institute of the Budapest Metropolitan Council in the construction of subsidiary roads without the use of stone, cement or asphalt.

Bare earth, consolidated to the texture of asphalt by the use of chemicals, is the basic material. An experimental section of road laid at Matyasfold, not far from Budapest, is being used by several hundred lorries a day. According to a report in the daily paper, *Szabad Nep*, the road is 'springy' and binds stronger every day.

An industrial waste product—used sulphite lye such as is discharged by paper mills—and other cheap chemicals are employed to 'set' the earth, which in time becomes stone hard. The formula and quantities were calculated in the laboratories of the institute by Dr. Andor Cservenka, who, with Mr. Tivadar Acs, worked out the new method.

It is stated that the new technique costs only a quarter of the orthodox method.

Research on fluid mechanics

THERE is an unexpected and fundamental similarity between the numerous difficulties which arise in such industrial applications of fluid flow as the ventilation of mines; the design of centrifugal pumps; the hydraulic transport of solids; friction losses in pipe fittings, etc. That these difficulties can be tackled most effectively by a team of specialists in fluid mechanics is the belief of the British Hydromechanics Research Association, which has been building up such a team in the eight years since its formation. During October, the Association held its 'open day' at its laboratory at Harlow, Essex, and from the apparatus and demonstrations which could be seen there it was evident that, despite the name 'Hydro' in its title, the Association is interested in all fluids, both gaseous and liquid.

One important investigation is concerned with the measurement of conditions inside a pipe transporting large solid material. The pressures required for the hydraulic transport of large solid material along pipes can be estimated with fair accuracy, but there is still no satisfactory explanation of the conditions of flow inside the pipeline. Laboratory experiments are being made in order to throw light on the mechanism of flow. Some interesting work has been carried out with a 3-in. experimental coal pumping plant which have shown that, except at high velocities, the pressure drop along the pipe is directly proportional to the concentration actually present inside the pipe, irrespective of the concentration of the delivered mixture.

An interesting exhibit was shown to illustrate experiments on the flow in pipelines of slurries containing very fine particles. The flow of suspensions of fine particles such as fly ash or chalk is not influenced significantly by gravity, but as the velocity is diminished a stage is reached where the pressure loss ceases to correspond with that for plain water. Comparisons of tests on the pipe flow of a fly ash slurry and its properties in a rotating cylinder viscometer showed that the pressure losses of such materials flowing in pipes can be closely related to the viscosity $\sim$ shear rate properties of the slurry. The high viscosity of such slurries sometimes extends the viscous flow region up to quite high velocities. Because of the variation of viscosity with shearing rate the Poiseuille equation for viscous flow is not applicable, and one which takes account of the variation of viscosity across the pipe diameter must be used.

Previous work has shown that the locking of hydraulic control valves can be caused by tapered clearances between the cylinder bore and the piston lands. For pressures up to about 1,000 p.s.i. it has been found that the locking force is directly proportional to the pressure. Since many users are interested in higher pressures, tests are being carried out at the B.H.R.A. at pressures up to 10,000 p.s.i. In this range the distortion of the piston and cylinder can be of the same order of magnitude as the original clearances, and viscosity of the oil can increase to several times its atmospheric pressure value.

Maintenance Problems with Mechanical-Draught Cooling Towers

(Part I)

By D. J. Tow, B.SC.(ENG.), DIPL.CHEM.ENG.

(Head of Projects Initiation Dept., Head Wrightson Processes Ltd.)

The question of cooling tower maintenance is one which has received too little attention from the chemical engineer. Here is the first part of an article which will point a way to increased life for induced-draught mechanical towers. This month the author discusses cooling water treatment and control, then goes on to describe the various types of structure available, discussing their effect on maintenance problems.

IN most chemical plants there is a programme of preventive maintenance for all operating equipment, but in too many cases the cooling towers are not included, owing perhaps to the inaccessible location of these towers. A contributing factor also may be that most cooling towers are often employed on duties for which they were not designed, and thus a decrease in efficiency is not readily noticeable. It should be remembered, however, that an adequate supply of cold water is most essential for satisfactory and efficient plant operation and, to ensure this supply, maintenance of cooling towers is of prime importance.

This paper will attempt to discuss the various maintenance problems that are encountered. The subject is dealt with in two parts: (1) the question of prevention of damage to cooling towers by the control of the circulating water and (2) the necessary periodic inspection and maintenance to ensure the continued operation of the tower.

It is important to remember that a cooling tower is a vital part of a process plant and represents a considerable capital investment, but this does not mean that the chemical engineer should seek to buy the cheapest cooling tower available. It is most important to attempt an economic appraisal of the various types of cooling towers offered before deciding on the tower for a particular job, because a tower which is high in first cost may have a longer life owing to its superior structural features and, as a result of this its annual cost, including, naturally, its maintenance, is considerably less than a tower with a low first cost.

It is generally agreed, the author believes, that the natural-draught cooling tower has become obsolete with the advent of the highly efficient mechanical-draught cooling towers, and because of this it is intended to deal specifically with the induced-draught type of mechanical towers (which have superseded the forced-draught type) in this article.

WATER PROBLEMS

The maintenance of a cooling tower is closely connected with the quality of the water used. It is therefore almost impossible to discuss cooling tower maintenance without discussing cooling water treatment, although the problem of water treatment is almost an entire field in itself. The opinions presented in this paper are not intended to be a solution to any specific water problem, but are given only as a guide. It is recommended that for any specific problem a company specialising in water treatment should be contacted. Briefly, however, water treatment should be undertaken for the following reasons:

(*a*) To control algae.
(*b*) To control scale formation.
(*c*) To prevent delignification of the timber used.

(a) Control of algae

Chlorine appears to be one of the most suitable agents for the control of algae. In many plants satisfactory algae control has been obtained by injecting 1 to 2 lb./day of chlorine for each 10,000 gal./hr. of water circulated. It is important to remember, however, that if this amount is consistently added to the water a type of algae immune to chlorine will soon develop. Therefore, every so often, possibly every week or so, for a short period, the amount of chlorine supplied to the system should be increased several times, thus preventing the development of this chlorine-immune algae.

(b) Control of scale formation

By controlling the *p*H of the cooling tower water it is possible to control the rate of scale deposition in piping and exchanger tubes. The tendency for a scale to deposit is greater as the *p*H of the water increases. When the *p*H is below 7, little or no scale deposition will occur, but of course with this acidic water the metals in contact with the water slowly begin to dissolve. The most satisfactory practice is to keep the *p*H of the water between $6\frac{1}{2}$ and 7 and then to add a corrosion inhibitor to the system. This inhibitor keeps the piping and exchanger tubes clean and prevents metal corrosion. It is recommended, however, that the above treatment should only be attempted under the advice of a water-treating specialist.

(c) Combating timber deterioration

It will be seen later in this paper that until recently it has not been possible to offer a satisfactory cooling-tower structure in concrete. The author believes that a concrete structure cast on site is unsatisfactory for a cooling tower and, in fact, until the recent development of a concrete pre-cast unit construction, most cooling-tower buyers preferred a timber construction with its evenly distributed load structure. It is therefore important that the chemical deterioration of cooling-tower lumber should be understood and combated.

Effect of delignification. The most important type of timber deterioration occurs as a result of delignification, which term describes the removal of alkali or bisulphite soluble matter. As its name implies, this chemical attack results in the dissolution of lignin, which material is largely responsible for the strength of the wood. However, the process as it operates in destroying a cooling tower is a complex one, since there are mechanical and other effects involved.

After delignification the cooling-tower timber is left as a fibrous cellular structure of extremely low strength. This residue is probably largely cellulose.

In one instance of cooling-tower failure in America,[1] large quantities of pure-white short cellulose fibre were recovered from a completely plugged pump and basin weir screens after severe and rapid delignification had occurred. In such a case, which, it must be agreed, is an extremely advanced one, the fact that the loose cellular structure will not hold nails or properly support other fastenings makes any normal repair method impossible and the only alternative is to completely replace the members that have failed.

Thus it may be seen that, in installations where delignification can occur in a cooling tower, the resultant damage is of considerable concern to the tower owner, since expense is incurred not only in repair of the damage but, in addition, disruption of plant operation. The above discussion should not be taken to imply that the phenomenon of delignification occurs in all cooling towers, but it is of sufficient frequency to warrant the interest of all persons concerned with the use of such equipment.

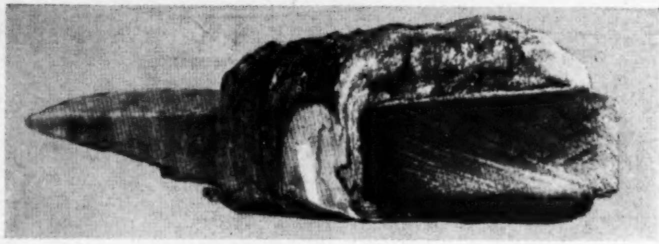


Fig. 1. A cooling tower beam showing how dirt and calcium deposits can impair a tower's efficiency and reduce its life.

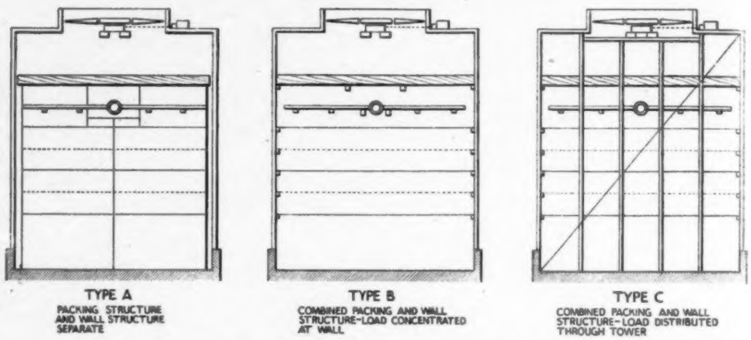


Fig. 2. Diagrams illustrating various types of cooling-tower structure.

Salt accumulations. Inspection of the available data indicates that high concentrations of neutral salts have little effect in promoting delignification as long as the *p*H of the solution is kept below 7½. Under acid conditions there is some wood destruction which cannot be classified as delignification, but becomes appreciable as the *p*H drops to 5 or lower.

Examination of the reported data on inspected towers indicates that delignification is excessive in localised areas where it is possible to attain very high salt concentrations (*circa* 30,000 p.p.m.) owing to evaporation and, in general, is considerably greater than in the tower areas which are continuously washed by the circulating water (Fig. 1). Tower life can be considerably prolonged by periodic washing of the affected areas, which prevents such salt accumulation.

In cooling-tower operation, high *p*H in the water is nearly always due to an accumulation of sodium carbonate, since free hydroxide is seldom encountered; therefore, it is possible to utilise the simple measurement of *p*H in the water as a qualitative indication of probable delignification resulting from carbonate accumulation. Finally, there is undoubtedly a further contributing factor in the areas in which salt encrustation is allowed to occur: any liquid phase in contact with such encrusted salts is necessarily saturated and such saturated solutions will tend to soak into the wood to some extent. On subsequent drying of the area involved, the salts are left behind and may decrepitate due to dehydration, resulting in rupture of the wood cell membranes or, on repeated rehydration, may swell again causing cell rupture.

Of all the salts commonly occurring in cooling-tower waters, sodium carbonate is unusual in its ability to cause this type of mechanical destruction.

Dealing with sodium carbonate

Since the conclusions drawn above indicate the undesirability of sodium carbonate in cooling-tower waters, the most obvious recommendation would be the elimination of this salt from the system.

Sodium bicarbonate itself has little effect in promoting delignification; however, the bicarbonate ion is readily converted to the normal carbonate, due to the increased temperature of the inlet circulating water and its aeration. For this reason it is obvious that *p*H control is of extreme importance in carbonate hard waters, since the carbonate-to-bicarbonate ratio increases with increasing *p*H and at values of 9 or higher most of the hardness is in the form of normal carbonate. This means, then, that it is not necessary to remove the carbonate completely by means of ion exchange or other treatment, but it is necessary to maintain the carbonate in the bicarbonate form, a requirement that is satisfied by keeping the *p*H of the water between 7 and 7½. Sodium zeolite treatment of carbonate hard circulating waters may lead to rather high concentrations of sodium carbonate and, if such a treating method is used, it is imperative that proper *p*H control be maintained, as otherwise sodium carbonate concentrations can easily become excessive.

Other treating methods probably can be used with reasonable safety, since, as has been pointed out, the presence of neutral salts in the water does not contribute appreciably to delignification, provided again, however, that the *p*H is properly controlled. Treating of the water is employed primarily for the protection of mechanical and structural metallic equipment, and it is therefore unlikely that a *p*H of less than 7 will be encountered, because acid waters in general are not suitable for use in contact with most structural metals. However, it is realised in some instances that inhibited waters of *p*H as low as 6 are sometimes used in circulating systems. This practice is probably safe, although it would be wise to keep the cooling-tower water *p*H value greater than 6½.

One rather special instance of

apparent delignification, also reported from America, is of interest. In the operation of a particular tower some waste chlorine was injected into the tower water as a convenient means of algae control. However, the residual chlorine content of this water was as high as 60 p.p.m. and, under these conditions, destruction was quite rapid in the cooling-tower packing, although the other conditions of the water, *p*H and sodium carbonate content, were reasonably satisfactory. This observation would indicate that excessive chlorine concentrations should be avoided and that, in general, oxidising materials should not be permitted to accumulate in any circulating water. The concentration of oxidising algaecides should be kept below 1 p.p.m.

The most important means of prolonging tower life is proper control of the water for sodium carbonate content and *p*H.

The two factors are interdependent, however, to a considerable extent, since control of *p*H between 7 and 7½ automatically limits the normal sodium carbonate content to a low value. Furthermore, as pointed out previously, delignification is nearly always greatest in those sections of the cooling tower which are so located that they undergo alternate wetting and drying with consequent accumulation of salt encrustations.

Periodic hosing or other cleaning of grid decks, drift eliminators and structural members would to a great extent eliminate this factor, and such treatment can be effected while the tower is in operation.

In the event of cessation of the tower operation as a result of general maintenance or repair shut-down, inspection of the tower should be made and all sections, including the basin, properly cleaned if necessary. The salt content of the water in the basin should be kept to an absolute minimum and, in order to do this and to remove any collected dirt, dust or other debris from the basin, it is recommended that a continuous blowdown be made part of the cooling-tower system.

TOWER PROBLEMS

Once the importance of the water problem is understood, the operator should next consider the organisation of a regular inspection and maintenance programme for his cooling equipment. This regular inspection programme should include the structure, outside covering, packing, drift eliminators, distribution system, basin and mechanical equipment.

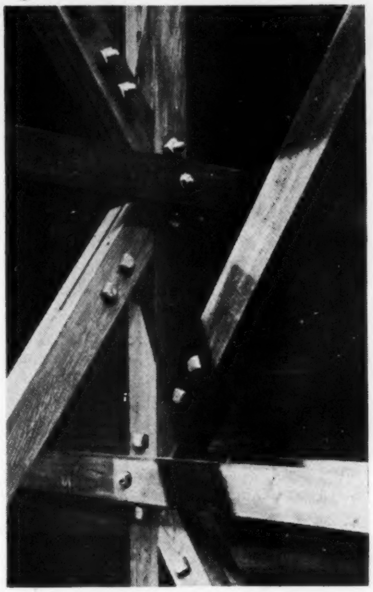


Fig. 3. All-timber tower structure showing diagonal braces.

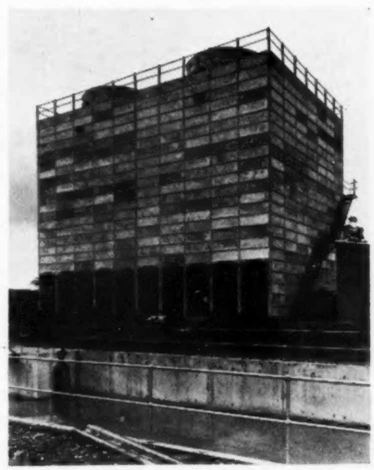


Fig. 4. Induced-draught cooling tower utilising precast concrete units.

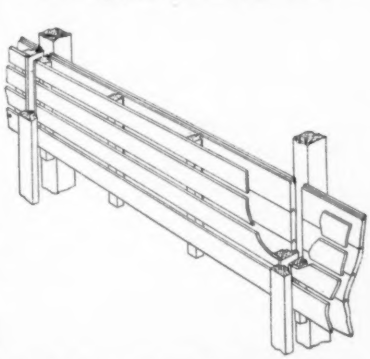


Fig. 5. Double-wall timber construction.

Structure

The various types of cooling-tower structure have been fully discussed elsewhere[2] and it is sufficient to mention here the general conclusions reached on this subject and their relevance to the problem of maintenance.

There are three main types of mechanical cooling-tower structure (Fig. 2):

Type A. The wall structure and the packing structure are separate.

Type B. The packing and wall structure is combined with the load carried at the walls.

Type C. The packing and wall structure is combined, but with the load distributed throughout the tower.

In this article we are mainly concerned with mechanical, induced-draught towers, for which type *A* structures, though used for concrete chimney-type towers, are uneconomical. This structure does not provide a satisfactory support for the fan and mechanical equipment.

In the type *B* structure, the walls are constructed with adequate bracing to resist the wind loading and the load imposed by the filling, distribution system and mechanical equipment on top. These internal fittings are supported on cross-members carried by the timber or concrete wall columns. It will be seen that in this type of structure all the foundation load is concentrated at the periphery of the tower and there is therefore a danger of the packing sagging during operation owing to the wide span of the supporting joists. In addition, the mechanical equipment is very poorly supported and the structure does not have the resilience necessary to absorb possible vibrations. It is concluded that such structures are satisfactory only for the smallest cooling towers.

Undoubtedly the most desirable structure for mechanical-draught towers is type *C*. Here the structure consists of columns disposed throughout the tower and beams join these transversely and longitudinally to give rigidity to the structure and to provide support for the packing and other internal fitments.

Timber and concrete in tower construction

In the case of towers with concrete walls, these beams, which may be of concrete or timber, are attached to the wall columns, which take all the horizontal load and part of the downward component of this load. Where an all-timber tower is selected the wind load is taken by diagonal braces

which transmit the load to the vertical columns (Fig. 3). In this type of structure the wind and dead load on the foundations is distributed across the whole ground area of the tower and not concentrated at the walls. In addition, the beams supporting the filling are not so liable to sagging, since they are supported on closer centres. This feature, combined with the resilience of three-dimensional structure, gives better support to the fan, gearbox and motor, and absorbs any slight vibrations which may occur.

As stated at the beginning of this paper, all-timber towers of this type are more usual at present. This is because the usual type of concrete cooling tower has certain disadvantages:

(1) Being cast on site there is the necessity of scaffolding and the use of timber formers.
(2) In the past this type of tower usually had timber columns with a concrete shell and this design gave a concentration of weight on the foundations at the periphery of the tower.
(3) With a longer on-site time comes difficult site construction problems.
(4) There is a susceptibility of concrete cast on site to deteriorate and flake due to water action.
(5) The great difficulty of subsequent tower extension.

Just recently, however, there has been an interesting new development in cooling-tower constructional technique regarding the use of precast concrete units for mechanical-draught cooling towers (Fig. 4). This method of construction enables loads to be evenly distributed in a satisfactory manner throughout the tower, thus eliminating many of the objections to conventional concrete structures as given above.

For the small and average-size cooling tower the all-timber tower is the cheapest, but naturally great attention must be given to the various structures offered by cooling-tower manufacturers with a view to lessening the requirements of maintenance after purchase.

New light on timber deterioration

A very interesting interim report on timber deterioration has just been issued by the Central Electricity Authority, in which certain conclusions were reached. The report describes the two types of rot—dry rot and wet rot—which are already known to exist, and mentions that these types of decay are now comparatively well understood and the treatment of timber to prevent them is well established and successful.

The report, however, goes on to say that the most common cause of deterioration in cooling towers in Britain is now recognised to be due to a group of microscopic fungi of the ascomycete type, which slowly dissolves away the cellulose of the cell walls of the outer surface of the timber, giving rise to what is now called ' soft rot.'

It concludes that the rate of penetration of soft rot in average conditions is about 0.01 in./yr. per surface. The report states that for longest cooling-tower life this destruction should be allowed for by suitably sizing all members in relation to their duty, and inferior timbers should be excluded. Tests were carried out on various types of timber, and the report concludes that most timbers readily available in Britain are inferior to Baltic redwood.

The investigations of the Central Electricity Authority are by no means complete on this subject, but the conclusions of this interim report and its focus of attention on timber deterioration caused by ' soft rot ' is most important.

The author believes that one of the main results of this report should be that cooling-tower buyers should investigate the structures offered to satisfy themselves that the various members, filling, etc., are of a size that will not disappear after a few years under this attack.

When inspecting a cooling-tower structure after it has been in operation, all joints should be checked for tightness. Suspected areas of fungus attack can best be detected by means of a sharp probe. The appearance of these affected areas is generally a dark, chequered, crumbly core or, alternatively, a light stringy core flecked with white, depending on the type of fungus.

Outside covering and louvres

Double-wall all-timber towers are often superior to the older single-wall type. This latter type of wall rapidly deteriorated due to warping and water leakage and, in addition, the single layer of boards was nailed to the structural members, these nails constituting centres of deterioration. In double-wall construction the wall consists of panels made up of two layers of boarding separated by an air space (Fig. 5). The inner boards are close together; the outer boards have gaps allowing air circulation. The inner board is protected from the cyclic effect of the weather and remains water-tight, being no longer subject to warping. The wall panels are not nailed to the structural members, but instead, binding cleats, bolted to the columns, hold the panels in position (Fig. 6). In the best designs the panels are prefabricated under workshop control and are thus water-tight, and only the joints between panels need to be sealed with bitumen compound. From a maintenance point

(Concluded on page 394)

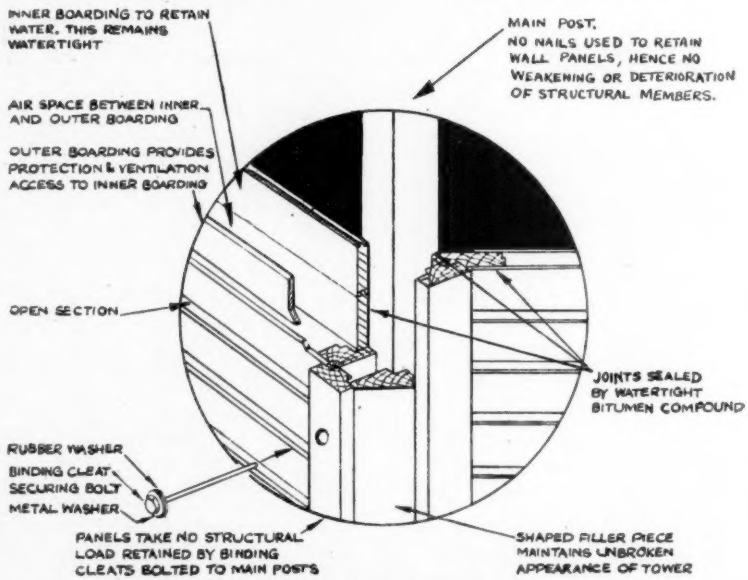


Fig. 6. Method of holding wall panels in position.

OZONE

2. Industrial Applications

By D. J. Saxby, B.SC., F.R.I.C.

(Chief of Research, Tack Air Conditioning Ltd.)

The remarkable properties of ozone are being put to an increasing number of uses in industry. These uses are discussed here, along with the various types of ozone generators that have been developed. This concludes the outline of the properties, manufacture and practical applications of ozone which was begun in our October issue.

Air conditioning

OZONE reduces stuffiness and fug and deodorises many unpleasant smells such as body odours and the smell of stale tobacco smoke, cooking vegetables and decaying organic matter.

There has been some controversy as to whether ozone actually destroys smells or merely masks them. There is considerable evidence to support both views and the truth of the matter is that some odours are masked and others are destroyed or converted to inodorous compounds. That many smells are destroyed by ozone can be shown either by isolation of the oxidation products or by the fact that a smell which would normally persist for several hours disappears when an ozoniser has been working for a short time and does not reappear when the ozoniser is turned off.

Before describing the construction of air-conditioning ozonisers, it should be mentioned that they work under quite different conditions from most industrial ozonisers, *i.e.* they are intended to deal with large volumes of weakly ozonised air, whereas industrial ozonisers are designed to produce relatively small amounts of highly ozonised air.

It has already been mentioned that ozone is generated by passing an electrical discharge between two electrodes which are separated by a dielectric and a small air gap. Ozonisers of this type are commonly used for industrial purposes, but their resistance to air flow is too great for air-conditioning work and a modified form of ozonising element is used. This consists essentially of two metal-gauze electrodes separated by a sheet of dielectric which may be glass, mica, micanite or some other suitable material.

Fig. 2 shows a tubular air-conditioning ozoniser element. A cylinder of metal gauze is held in close contact with the inner wall of the dielectric tube by means of an expanding device and a second cylinder of gauze is clamped on the outside of the tube. When an alternating voltage of 2,000 to 6,000 v. is applied across the gauze cylinders, ozone is generated at the surface of the gauze.

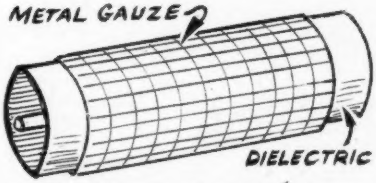


Fig. 2. Diagram of tubular air-conditioning ozoniser element.

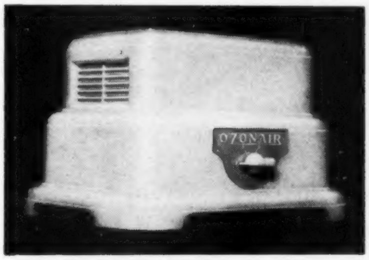


Fig. 3. Small ozoniser without fan, suitable for kitchens or small offices.

Ozone generators may be fitted into existing air ducts, but it is usually more convenient to use self-contained units.

Small ozone generators, suitable for rooms up to about 1,500-cu.ft. capacity, usually take the form of a small cabinet containing one or more ozonising elements, together with a high-voltage transformer and control switch. A typical unit is shown in Fig. 3.

For the efficient ozonisation of large premises it is essential that the unit should include a fan which not only circulates ozonised air throughout the space to be treated but also cools the ozonising elements. Deposition of dust on the elements would cause a serious drop in efficiency, hence units fitted with fans must also be equipped with air filters.

Fig. 4 illustrates a larger unit. Air, which is drawn into the rear of the unit through an air filter, becomes ozonised during its passage over the ozonising elements and is discharged through the louvres on the front of the unit. A variety of units, suitable for all types of premises, are now available and are extensively used in shops, kitchens, restaurants, slaughterhouses and many other places where unpleasant odours are likely to arise.

Cold storage

Ozone is frequently used in cold stores to prevent or retard the spoilage of foodstuffs by surface growths of moulds and bacteria. The ozonisers used for this purpose are similar to those already described, but they are usually larger and are specially constructed to withstand the severe conditions which prevail in cold stores.

In order to obtain satisfactory control of surface growths, the temperature must be below 38°F. and a relatively high ozone concentration must be used; the latter is usually maintained between 0.5 and 3 p.p.m. according to the type of foodstuff which is to be preserved. Concentrations as high as this cannot be breathed without discomfort and the ozonisers are, therefore, turned off before workers enter the chamber. Ewell has shown that ozonisation for several periods during the day is almost as effective as continuous ozonisation.

Ozone can be used with advantage for the storage of meat, fruit, cheese and eggs. Its effectiveness in controlling mould growth depends to a great extent on the condition of the foodstuffs before they enter the store. Ozone will not control mould growth on badly contaminated foodstuffs which would normally be considered as unfit for storage; its rôle is to prevent the spread of infection rather than to sterilise badly infected food.

Another problem which occurs in cold-storage practice is that a chamber which has been used for storing strongly smelling foods, such as citrus fruits, cannot be used for other types of foodstuffs until the odour has disappeared. In the normal course of events it may be several weeks before the store is odour-free and ozonisation is often used to hasten destruction of the odour.

Large portable ozonisers, such as shown in Fig. 5, are wheeled into the store and operated continuously. The space soon becomes filled with a bluish haze and deodorisation is usually complete in about a day.

Water purification

Ozone has been used for many years for the sterilisation and purification of public water supplies and some two or three hundred plants have been installed on the Continent for this purpose.

A number of ozone plants have also been installed in swimming pools for sterilising the water and they have, in some instances, also been found useful for decolorising water from peaty districts.

The advantages of using ozone for water purification are that it introduces nothing but oxygen into the water and never produces unpleasant tastes or taints. It also reduces colour and improves sparkle.

In Europe ozone is frequently used as a sterilising agent in place of chlorine, but in the United States its application is somewhat different in that it is used for removing residual odour, taste and colour from water which has already been chlorinated.

The plant consists essentially of a blower, an air drier, a bank of ozonisers and an injector. Drying of the air is essential and is normally effected by silica gel or activated alumina, with or without pre-drying by refrigeration.

The ozonisers themselves may be of the plate or tubular type, ozone being produced by blowing air through an electrical discharge.

Plate-type ozonisers consist of a series of parallel metal plates. Alternate plates are insulated from each other and are separated by a glass plate and an air gap of a few millimetres, the arrangement resembling an electrical condenser in which the dielectric consists partly of glass and partly of air. Alternate plates are connected in parallel to a high-voltage alternating supply.

Tubular elements may be of several types, but consist in effect of two concentric metal tubes separated by a glass sleeve and a narrow air gap. Air is, of course, pumped through the annular space. Both plate and tubular ozonisers are usually provided with water-cooled electrodes or are enclosed in a water-cooled chamber.

The air leaving the ozonisers is then introduced into the water by means of an injector, the object being to obtain as complete mixing as possible between the water and the ozonised air. After injection, the water is usually allowed to remain in contact with the ozone for 15 to 30 min., after which time reaction is complete and most of the ozone has decomposed.

Ozone, when properly applied, will kill practically all micro-organisms which are likely to be present in water. It is, however, absolutely essential that the water leaving the injection chamber should contain a slight excess of ozone, *i.e.* it should give a positive reaction when tested with starch-iodide. A large excess of ozone does no harm and is only undesirable because it increases operating costs.

The ozone dosage is usually about 2 p.p.m. (2 g./cu.m.),[9] but it varies according to the nature of the water and depends on the amount of oxidisable material present and not on the degree of bacterial contamination. Reducing compounds must be oxidised before the ozone can exert its bactericidal effect.

Chemical industry

Ozone is used in the chemical and allied industries both as an oxidising agent in chemical manufacture and for the treatment of fumes and effluents.

It is, of course, useless for dealing with inorganic odours, with the exception of hydrogen sulphide, but is excellent for the destruction of the odours arising from many industrial processes such as the manufacture of fish products, the processing of bones and vegetable and animal refuse, and the manufacture of glue, gelatine, isinglass and soap. The odours are extracted through a tall chimney and ozonisers of the air-conditioning type are arranged to blow ozonised air into the base of the stack.

Ozone is also invaluable for the deodorisation of casks, containers and storage bins.

Crude effluents can be treated with ozone, but it is usually more economical to pretreat the effluent to remove gross impurities and to ozonise finally in order to destroy bodies which cannot be removed by other means. This method has proved to be very efficacious for the removal of traces of phenols from coke-oven plant effluents.[10, 11]

Ozone as an oxidising agent for chemical manufacture is produced by generators which are very similar to those used for water treatment. An apparatus suitable for pilot-plant or small-scale processes is shown in Fig. 6. Capital costs are relatively high, but the cost of production, when considered in terms of equivalent oxidising power, is often less than that of more conventional oxidising agents.

The efficiency of ozone generation depends on the type of plant used and the concentration of ozone which is required. Including power consumption of blowers and air driers, a yield of 20 to 40 g./kwh. is generally to be expected.

The choice of ozone for a particular purpose depends on several factors; for example, ozone may be the only oxidising agent which is effective, it may be cheaper or more effective or more rapid in action, or it may be

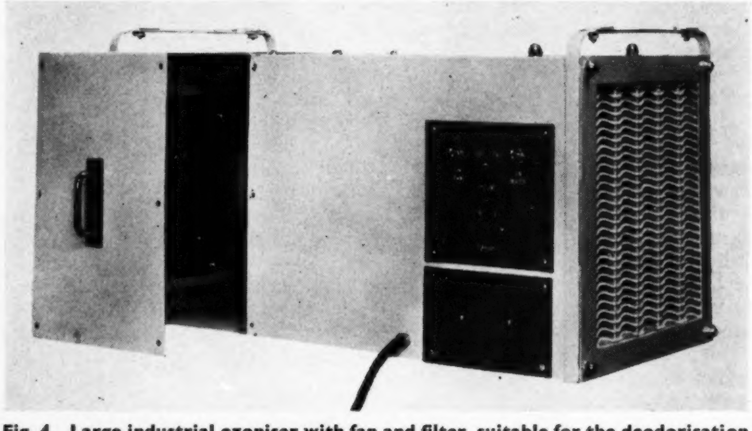
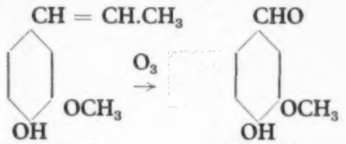


Fig. 4. Large industrial ozoniser with fan and filter, suitable for the deodorisation of spaces up to 30,000 cu. ft.

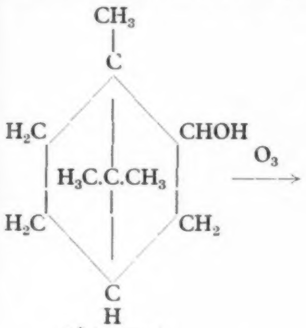
preferred because it adds nothing but oxygen to the material being treated.

One of the earliest uses of ozone was for the oxidation of isoeugenol to vanillin:

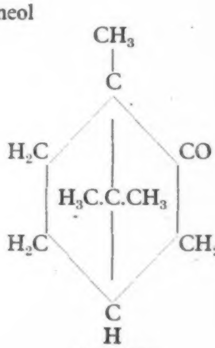


Isoeugenol Vanillin

Other reactions of technical interest are the oxidation of indigotin to indigo and camphene or isoborneol to camphor.[12] It is stated that in Germany ozone has practically replaced potassium dichromate for the latter purpose.



Isoborneol



Camphor

In the field of synthetic perfumes, ozone is used for the preparation of heliotropin from piperic acid or isosafrole.

Manganates are oxidised to permanganates and ferrous salts can be oxidised without the use of nitric acid.[13]

Ozonolysis is usually carried out in solution and if, as is frequently the case, it is necessary to use an organic solvent, care must be taken that the solvent itself is not susceptible to oxidation by ozone. Many common solvents, such as ether, alcohol and benzene are readily oxidised and chlorinated solvents may give rise to carbonyl chloride. Ethyl acetate or glacial acetic acid or a mixture of the two are commonly used.

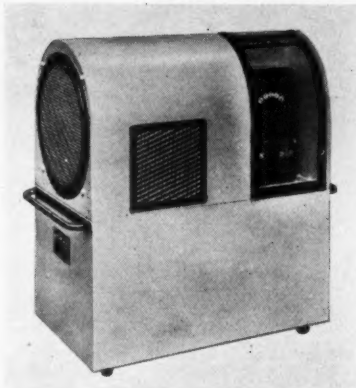


Fig. 5. Large portable ozoniser for cold stores, suitable for capacities up to 40,000 cu. ft.

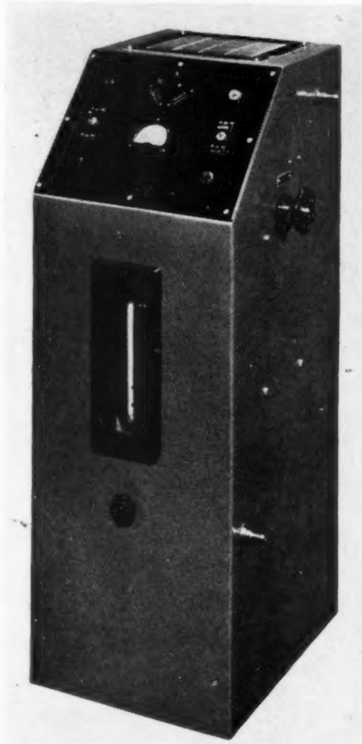


Fig. 6. Small industrial ozoniser, comprising ozone generator, flow gauge, control gear and air drier, suitable for laboratory or pilot-plant work. Ozone output 3 g. hr.

Beeswax and other waxes are purified by passing ozone through the molten wax. Bleaching takes place and the melting point and hardness of the wax are increased.

In Italy ozone is said to be used on a large scale in the manufacture of oils, varnishes and soaps.

Bone grease is deodorised and bleached and blue oils lose their fluorescence when treated with ozone. Fish, animal and vegetable oils are bleached, deodorised and rendered fit for soap manufacture and linseed oil is oxidised with ozone before varnish marking.

In this article some attempt has been made to outline the properties, manufacture and practical applications of ozone. Much remains unsaid and, in the space at our disposal, it has been impossible to deal with other aspects of the subject, such as the use of ozone in the laboratory for the identification of compounds and the elucidation of structures and its applications in dentistry, medicine and surgery.

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New Copper-plating Anodes

It has been found that electroplaters can obtain smoother copper plates from high-efficiency baths when the copper is supplied from high-purity, high-density cast anodes rather than from ordinary cast, rolled or electrolytic-copper anodes. The results of these experiments support shop observations that have been reported since this oxygen-free, high-conductivity cast form of copper anode became available about two years ago.

Particular attention was given to producing smooth plate without the use of anode diaphragms. The plating was done with high-efficiency copper cyanide baths. Under many plating conditions, oxygen-free, high-conductivity anodes performed better than other types of anodes. For example, in both air and mechanically agitated solutions, the high-purity, high-density cast anodes gave smoother plates than other types of anodes. With little or no agitation, results were the same as those for other types of anodes.

W. H. Safranek and C. L. Faust reported the results of the experiments at the 42nd annual convention of the American Electroplaters' Society, in Cleveland recently. Both men are on the staff of Battelle Institute, Columbus, Ohio, where the study was conducted for the American Metal Co. Ltd.

Production and Costs in Australia's Sulphuric Acid Industry

Australia aims to produce 65% of her sulphuric acid requirements from indigenous raw materials by 1956. This target can be reached if economic conditions prove favourable, as is shown by a recent survey of the industry. Some facts and figures from this survey are recorded in the following article.

AN enquiry by the Australian Government into questions concerning the sulphuric acid industry has led to the revelation of some interesting facts about the productive capacity of the industry, its capital expenditure, and capital and raw materials costs experienced there. The enquiry was held by the Tariff Board as a result of the situation which developed after supplies of brimstone from the United States and other sources became available once more following the world sulphur shortage. To enable them to support the Government's policy of increasing the proportion of acid manufactured from indigenous raw materials, Australian manufacturers felt the need for a bounty to be paid to them which would offset the difference between the cost of producing acid from local raw materials and that of manufacturing it from cheap imported brimstone. After considering all the evidence the Board recommended the payment of a bounty subject to certain conditions.

This article is concerned not so much with the bounty question as with the state of the Australian industry as revealed in the Tariff Board's report.

Raw materials and production costs

No economic deposits of brimstone are known to exist in Australia, but there are reserves of pyrites, lead zinc and copper sulphides, sufficient to last for more than 60 years if sulphuric acid is produced from these ores at the rate of 600,000 tons p.a. The known Australian reserve in this form is 18,400,000 tons of which 13,400,000 tons are readily available.

Estimated capital costs per ton-year of sulphuric acid capacity for various types of acid-producing plants are given in Table 1.

Local costs of producing sulphuric acid from indigenous materials are seriously affected by wide variations in the costs of individual items; thus, the price per ton of pyrites 'at mine' ranges from £A3 to £A8, while the freight per ton from mine to acid plant ranges from £A2 to £A6.

Some acid manufacturers stated during the enquiry that production of acid from pyrites was not economic at present and that purchases of pyrites to a value of £150,000 (50,000 tons) were being stockpiled at mine or port of shipment. Current capacity of plant producing acid from pyrites was in excess of actual production.

A summary of production statistics for the Australian sulphuric acid industry is presented in Table 2.

Industry's plans and problems

The manufacturing companies making requests for a bounty confined their reasons to well-defined premises, *viz.:*

(*a*) The recent fall in the landed cost of sulphur has placed the manufacture of sulphuric acid from indigenous raw materials in a disadvantageous position of cost; the lower cost of brimstone was made possible, despite overseas price increases, as the result of reduced freight charges.

(*b*) With the encouragement and support of Commonwealth and State Governments, acid manufacturers have planned and are undertaking extensive constructional conversion programmes aimed at the production of increasing amounts of acid from Australian raw materials; cost disadvantages are now jeopardising the success of these programmes which are considered essential in the light of future possible fluctuations in the landed cost of brimstone.

After reaffirming its policy that conversion of existing sulphuric acid plants from the consumption of brimstone to that of indigenous materials is desirable, the Commonwealth Government suggested that manufacturers should aim at producing 65% of Australia's requirements of acid from local materials by 1956. It also suggested that a pool should be formed by the industry for purchasing, distributing and equalising the cost of brimstone and pyrites. The industry considered that the latter proposition is impracticable, but that the conversion target could be achieved subject to protection against cheap imported brimstone and provided that the increase in demand did not exceed 10%.

As the result of the recent world shortage of sulphur, Australian sulphuric acid manufacturers accelerated programmes to convert plants to consume indigenous material and have involved themselves in heavy commitments. The result of this expenditure is not yet reflected in increased output of pyritic acid, and is not expected to be so until 1956.

Plans for the conversion of existing acid plants to use Australian raw materials and for the erection of new plants for this purpose exist and are being carried out in all States of the Commonwealth. The principal material to be used is pyrites, but appreciable quantities of acid will be produced from zinc concentrates ('sinter gas'). A small percentage is derived from spent oxides.

The bulk of the pyrites at present being used in Australia is obtained as a by-product from copper production at Mount Lyell in Tasmania, Mount Morgan in Queensland, and Captain's Flat in New South Wales. Pyrites is produced as a main product at Norseman, Western Australia, and is about to be produced at Nairne, South Australia.

Raw materials other than pyrites

Zinc concentrates are produced at Broken Hill, N.S.W., and Rosebery, Tasmania, and the gases from roasting are used for the production of sulphuric acid at several plants. It is

Table 1. Capital Costs per Ton-year of Sulphuric Acid Capacity

Type of plant	United Kingdom	Australia
	£(Aus.)	£(Aus.)
Chamber brimstone	11.25	11.50
Contact brimstone	11.25	11.25
Chamber pyrite	22.50	20.90
Contact pyrite	22.50	22.50

Sources: United Kingdom Ministry of Materials and one Australian manufacturer, 1954.

Table 2. Sulphuric Acid Industry (Australia)—Summary of Production Statistics
(Unit: Long tons—100% acid and brimstone)

	1951-52	1952-53	*Quarter ended March, 1954*	*Quarter ended March, 1953*	*First three quarters, 1953-54*	*First three quarters, 1952-53*	1953-54 *estimates*	1954-55 *estimates*
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Brimstone for acid	130,000	114,000	39,356	27,772	106,000	81,000	145,000	167,000
Brimstone for other purposes ...	10,000	8,000	1,858	1,731	5,000	6,000	7,000	9,000
Total brimstone used ...	140,000	122,000	41,214	29,503	111,000	87,000	152,000	176,000
Brimstone acid	383,000	338,000	116,904	81,683	314,000	240,000	422,000	488,000
Pyritic acid	161,000	185,000	46,904	44,773	136,000	133,000	179,000	176,000
Zinc concentrate acid	101,000	94,000	24,822	19,928	75,000	68,000	101,000	97,000
Spent acid	9,000	11,000	2,407	3,049	9,000	8,000	13,000	13,000
Total acid produced ...	654,000	628,000	191,061	149,458	534,000	449,000	715,000	774,000
Acid used for superphosphate ...	547,000	519,000	159,717	126,405	439,000	372,000	614,000	643,000
Acid used for other purposes ...	111,000	108,000	32,174	24,380	93,000	77,000	126,000	160,000
Superphosphate produced ...	1,597,000	1,597,000	467,798	388,107	1,286,000	1,140,000	1,733,000	1,792,000
Superphosphate sold ...	—	1,583,000	662,536	579,928	1,112,000	1,123,000	—	—

(*Source:* Sulphuric Acid Executive Committee, 1954)

Table 3. Capital Outlay of Australian Sulphuric Acid and Fertiliser Industry since 1950

	£A (*millions*)	%
Conversion of existing brimstone-burning plants to burn pyrites	1.18	7
Construction of new acid plants	7.57	42
Conversion and construction of acid plants	8.75	49
Estimated capital cost for additional fertiliser manufacture ...	7.03	40
Estimated cost incurred or committed by manufacturers for sulphuric acid and fertiliser manufacture (including that on production of ammonium sulphate and incidental plant and equipment)	15.78	89
Estimated cost for development of pyrites production ...	1.97	11
Total capital expenditure incurred by acid and fertiliser manufacturers, and by producers of pyrites	17.75	100

proposed to abandon the roasting of zinc concentrates in South Australia in the near future and to confine this activity to Tasmania. Increased plant is being installed in the latter State for this purpose and for the recovery of acid, the additional production of which will be used largely in the manufacture of sulphate of ammonia.

The Broken Hill Associated Smelters Pty. Ltd. has installed a new plant to produce acid from the gases resulting from the treatment of lead concentrates. This plant is at present operating on brimstone and as such has a capacity of 50,000 tons p.a. of acid; the changeover to concentrates will reduce capacity to about 45,000 tons.

Capital outlay

Capital expenditure incurred since 1950 by the Australian sulphuric acid and fertiliser industry has been estimated by the Sulphuric Acid Executive Committee as set out in Table 3.

Of the seven new sulphuric acid plants which are being constructed or have been recently completed, two will burn sulphur. It is understood that these two plants, which are situated at Cairns, Queensland, and Albany, Western Australia, are convertible to the use of pyrites, should such a course become economically practicable. Furthermore, the joint capacity of both plants, when completed, will form only a very small percentage of the total sulphuric acid manufacturing capacity throughout Australia. Conversion and construction of plants to consume indigenous materials therefore comprised almost the whole of the capital expenditure which has been outlaid on conversion and construction projects, this amount forming 49% of the total capital expended since 1950 by acid and fertiliser manufacturers.

Brimstone imports

The British Phosphate Commissioners, at the request of the Australian and New Zealand Governments and sulphuric acid manufacturers, undertake the purchase, shipment and distribution of brimstone in both countries. Brimstone is purchased in the United States on an f.o.b. basis and is distributed throughout Australia on a ' pool ' basis at a uniform c.i.f. and e. price.

During the period when sulphur was short on the market, a quantity was purchased at prices up to £50/ton from Japan where sulphur interests were taking advantage of the shortage. Recent approaches from that country, however, indicate that it is prepared to lower its brimstone price to Australia by a large amount and to go so far as selling at a price below cost of production in order to further sales in Australia. Despite this possibility it is most probable that the U.S. will remain the principal supplier to Australia.

Details of sulphur imports are set out in Table 4.

Acid-from-pyrites costs

It is generally less costly to produce sulphuric acid in Australia from brimstone than from pyrites. Capital costs of plants consuming pyrites are much higher than those in which elemental sulphur is burned. At this enquiry, it was stated by a representative of Sulphide Corporation Pty. Ltd. that the company's new plant, burning pyrites and capable of producing 35,000 tons p.a. of sulphuric acid, was being constructed at an estimated cost of £1,065,000. A plant of the same capacity, burning brimstone, would cost, it was stated, approximately £440,000.

Other evidence on this subject indi-

Table 4. Australian Imports of Sulphur, 1937-39 and 1950-53

Country of origin	*Sulphur (brimstone)*				*Sulphur including Brimstone—Statistical Item* 3881					
	1937-38		1938-39		1950-51		1951-52		1952-53	
	Cwt.	£A	Cwt.	£A	Cwt.	£A	Cwt.	£A	Cwt.	£A
U.K.	2,747	1,611	3,074	2,857	3,069	3,691	36	222	527	3,327
Palestine	—	—	441	147	—	—	—	—	—	—
New Zealand	—	—	—	—	44	284	—	—	—	—
France	52,480	11,980	799	415	—	—	—	—	—	—
Germany	170	620	59	140	—	—	—	—	—	—
Italy	732,530	169,266	2,663	1,386	2,089,077	2,867,631	2	3	—	—
Japan	371,657	91,684	—	—	—	—	—	—	535,010	1,199,605
U.S.A.	1,676,138	388,751	2,294,654	554,840	1,226,296	643,942	1,682,514	980,774	2,077,796	1,307,201
Netherlands	—	—	—	—	—	—	—	—	30,440	39,058
All others	205	136	314	196	200	388	36	147	285	1,134
	2,835,927	664,048	2,302,004	559,981	3,318,686	3,515,936	1,682,588	981,146	2,644,058	2,550,325

cated that the cost of a pyrites-burning plant is about twice the cost of a plant based on brimstone (as also in the United Kingdom). One reason for the higher cost is that greater chamber capacity is necessary for a plant based on pyrites.

Usage of materials other than pyrites

Zinc concentrates. Sulphuric acid is at present manufactured from zinc concentrates by the Electrolytic Zinc Co. of Australia Ltd. at Risdon, Tasmania, and Port Pirie, South Australia, and by Wallaroo-Mount Lyell Fertilisers Ltd. at Birkenhead (Port Adelaide) and Walleroo, South Australia.

The concentrates are produced at Broken Hill, N.S.W., and Rosebery, Tasmania.

Production in Tasmania will increase progressively within a short period whilst the South Australian plants will gradually cease roasting zinc concentrates.

Sinter gas. A new sulphuric acid plant installed by the Broken Hill Associated Smelters Pty. Ltd., at its Port Pirie works, is at present operating on imported brimstone. Work is proceeding with a lead-sintering and gas-purification plant; when this is completed the sulphur in the gases from the sintering process will be converted to sulphuric acid. As in the case of acid produced from other materials, by far the greater amount is disposed of in the manufacture of superphosphates.

Spent oxide. The capacity of acid plants using this sulphur-bearing material is approximately 2% of the total Australian sulphuric acid plant capacity. It is not anticipated that this will be increased within the near future.

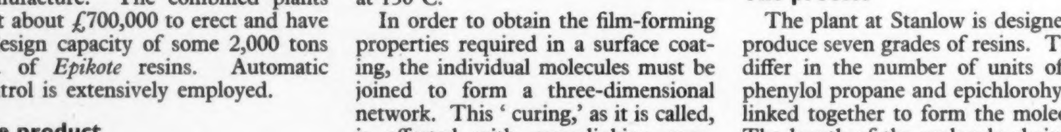
Epoxide Resins from Stanlow

SHELL'S NEW 'EPIKOTE' PLANT GOES INTO OPERATION

A NEW plant brought into operation at Stanlow by Shell Chemical Co. Ltd. recently will produce epoxide resins, while an associated plant will produce diphenylol propane—one of the raw materials for epoxide resin manufacture. The combined plants cost about £700,000 to erect and have a design capacity of some 2,000 tons p.a. of *Epikote* resins. Automatic control is extensively employed.

The product

The *Epikote* resins are a new type of condensation polymer developed by Shell. The resins are clear, amber-coloured liquids or solids made by reacting diphenylol propane with epichlorohydrin in the presence of caustic soda solution. They have the following general structure:



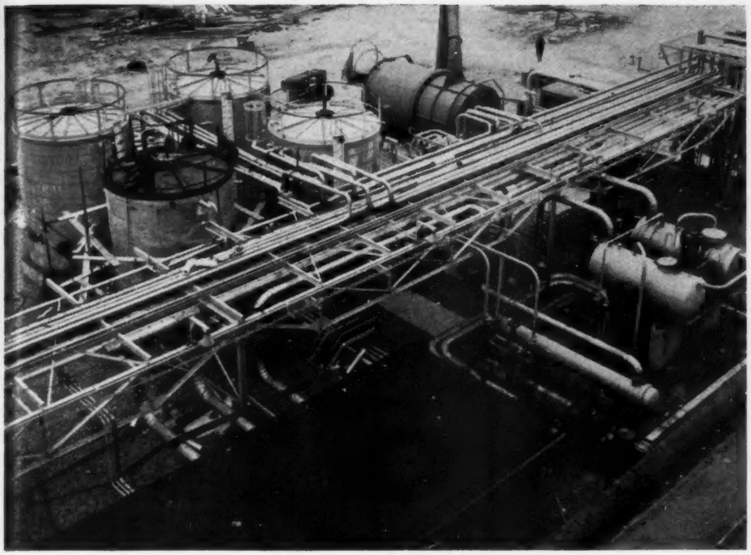
The resins can be manufactured in different grades which vary solely in molecular weight, *i.e.* in the value of *n* above. Thus, of the grades available, the extremes are respectively a viscous liquid and a hard solid melting at 150°C.

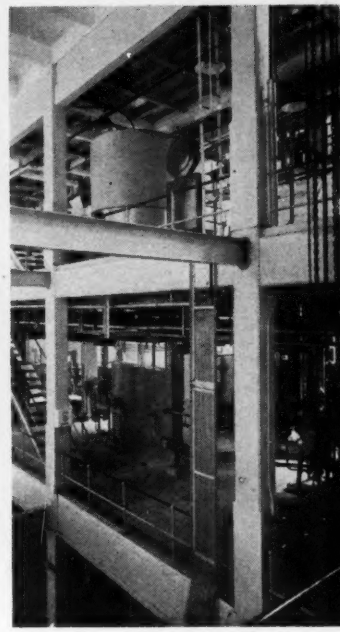
In order to obtain the film-forming properties required in a surface coating, the individual molecules must be joined to form a three-dimensional network. This 'curing,' as it is called, is effected with cross-linking compounds such as polyamines, phenolic or amino resins, etc., or esterification with fatty acids.

The diphenylol propane (DPP) used at Stanlow is prepared from acetone and phenol in an associated plant. The acetone used is derived from gases occurring in the refining of petroleum fractions. The epichlorohydrin (ECH) is also produced from petroleum refining gases, but is at present imported from the United States.

The process

The plant at Stanlow is designed to produce seven grades of resins. These differ in the number of units of diphenylol propane and epichlorohydrin linked together to form the molecule. The length of the molecule chain can be varied by altering the proportions of DPP and ECH in the reaction system. The more DPP used the longer the chain. The short-chain resins are syrupy liquids. The long-chain resins are solids. The reaction of DPP and ECH takes place with the evolution of heat and, after stirring





Two views of *Epikote* unit showing (*above*) oil-heating furnace and chemical storage tanks, and (*right*) inside of plant with reactors and instrument panel at bottom right; weigh tank at top centre.

for a period, the material is allowed to settle. The upper water layer contains salt and is skimmed off and the 'taffy' or reaction product is carefully washed with very pure water to remove traces of inorganic chlorides.

After the reaction, the dry molten resin is run out into stainless-steel trays where it solidifies. The resin is broken up into fairly large pieces and is then passed through a crushing machine to ensure a consistent size of particle.

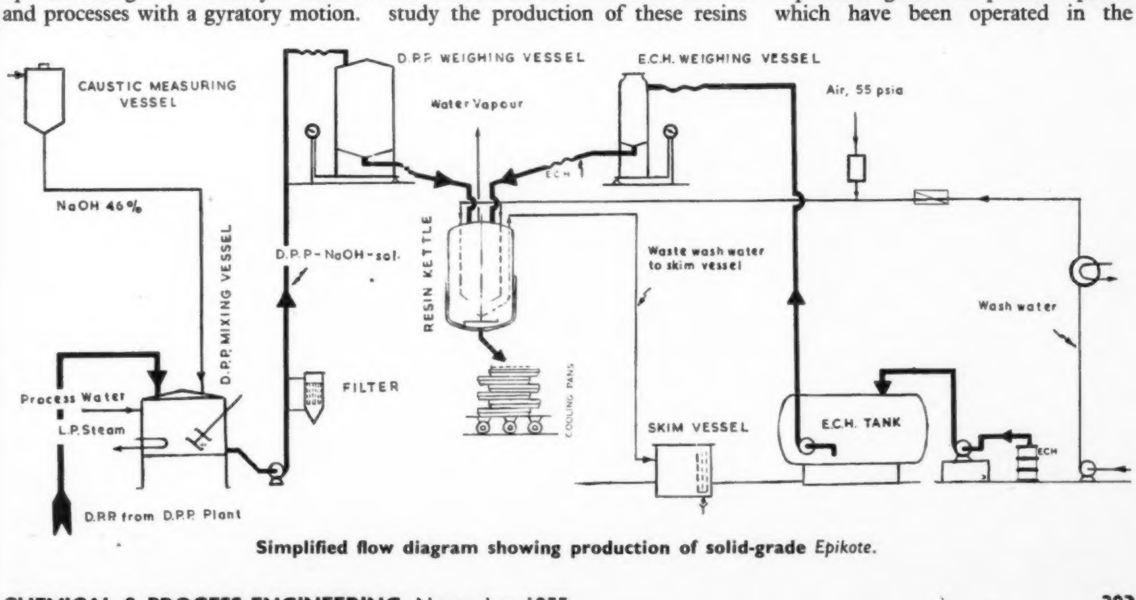
The crushed resin is blended in a vertical conical mixer in which an upward-lifting screw conveyor rotates and processes with a gyratory motion. The blended material is packed by machine into strong paper-lined sacks to a standard weight. The sacks of finished resin are stored on pallets according to grade.

For the liquid grades the solvent-free liquid resin is filtered through a horizontal leaf filter direct into drums.

Although the process is a relatively simple one, there is a considerable amount of 'know how' involved and, in order to benefit from experience and technique already obtained on early plants, the plant technologist was sent first to Holland and subsequently to the United States. He was able to study the production of these resins from the U.K. angle and returned before the Stanlow plant was finished to see it through to completion. The experience gathered in these visits has proved invaluable, and allowed the plant to start up smoothly and with less trouble than is normally associated with this type of unit.

The plant

The *Epikote* and diphenylol propane plants were designed by Shell's associates in Holland and were erected by a British engineering contracting firm. The designers drew fully on experience gained in previous plants which have been operated in the



Simplified flow diagram showing production of solid-grade *Epikote*.

United States and Holland for some years.

DPP is made on the ancillary plant and is stored in drums until required for use or for sale. Particular attention was paid to the design of drum-filling apparatus to avoid the formation of dust.

Imported ECH is received in drums and is decanted and stored in bulk until required. The quantity of this component required for a reaction is either weighed out using a stainless-steel vessel permanently positioned on a large scale, or for the liquid grades is measured into the reaction stream by a pre-set automatic cut-off displacement meter.

The caustic soda which is used to dissolve the DPP slurry is received and stored in bulk.

In the case of the liquid-grade resins the washing of the reaction product is carried out in hydrocarbon solution, and facilities have been provided to receive and store toluene and reclaim it from the reaction mixture.

The streams of reactants are carefully filtered before addition to the reactor. For the DPP solution these filters are constructed in stainless steel, and for the wash water porous stone filters are used.

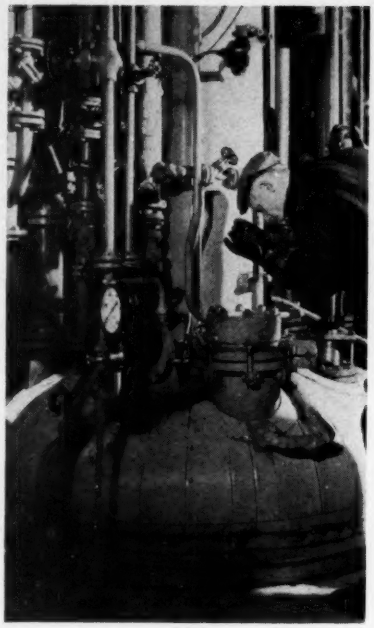
The plant is equipped, wherever possible, with controllers, which in some cases determine the temperature and control the flow of heating material accordingly, or in other cases determine automatically the acidity of the wash water and give an alarm if a certain value is exceeded. These automatic instruments allow the number of personnel employed on the plant to be kept to a minimum.

The heart of the plant is two large reactors of all-welded stainless-steel construction. Each of the reactors is equipped with a massive anchor-type stirrer, the blades of which were cast from stainless steel, while their shafts are of mild steel clad with stainless steel. Each stirrer is driven by an 83-h.p. motor coupled to the shaft by a variable-speed hydraulic drive.

The plant has been so designed that two similar reactors can be installed so that the increasing demand for these resins may be met.

The wash water is introduced below the 'taffy' level and is drawn off up a pipe which is controlled so that it is just below the surface of the liquid. A slight positive pressure applied to the vessel causes the wash water to rise through the 'dip' pipe.

One of the reactors will normally be used for the production of liquid grades and is equipped with a reflux head arranged to remove water from the system and to return to the reactor the excess ECH which is used for these grades. Solvent recovery may be effected by reducing the pressure of the system by a vacuum set. Either reactor can be used for the production of solid grades.



A further view inside the *Epikote* plant showing top of reactor kettle. Operator is adjusting dip-pipe level.

Laboratory tests

To ensure that the quality of the *Epikote* resins produced is uniform with that produced in other parts of the world, special equipment has been imported from Holland, Switzerland and the United States. The laboratory technicians responsible for the testing of the resins were sent to Holland for training and worked side by side with their Dutch colleagues to familiarise themselves with the techniques involved. Among the tests carried out on the batches are the actual formulation of paints and varnishes, and their application to pieces of metal, which are subjected to performance tests for flexibility, chemical resistance and adhesion.

Applications of 'Epikote' resins

The industrial applications of *Epikote* resins in the surface coatings field include coatings for the protection of domestic equipment and industrial machinery, can coatings, drum linings, tank coatings and chemical-resistant finishes for chemical plant. Three advantages claimed for these resin finishes by the makers are high resistance to chemical attack (due probably to the preponderance of carbon-carbon and carbon-oxygen bonds), good adhesion and excellent flexibility.

It is interesting to note that the new resin plant at Stanlow has itself been coated throughout with *Epikote* resin-based finishes. The resin is manufactured in caustic soda solution and therefore, Shell point out, the finishes used must be very resistant to alkali.

Another plant at Stanlow in which *Epikote* resin protection has been applied is the *Teepol* detergent plant, where very corrosive conditions are prevalent.

Maintenance Problems with Mechanical-Draught Cooling Towers

(*Concluded from page* 386)

of view the great advantage of this type of panel construction is that, since the life of the structural framework usually exceeds that of the walls, independent panels can easily be removed and replaced at the end of their useful life.

REFERENCES

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[2]Hayter and Trowbridge, *Ind. Chem.*, 1954 (1).

In the second part of this article the author will continue his discussion of the inspection and maintenance of cooling towers, going on to deal with tower packing, drift eliminators, the distributing system, basins, mechanical equipment, gears, couplings, fans and motors. A maintenance schedule for mechanical-draught cooling towers will be included, and also recommendations regarding the operation of towers in the winter.

Reinforced plastics. The very rapid development during the last few years of low-pressure synthetic resins and of glass-fibre cloths, mats and roving for reinforcement has placed new structural materials at the disposal of industry. These reinforced plastics are no mere substitute for steel or other metals; they have unique properties of their own—high strength, low weight, chemical inertness and ease of forming—and many manufacturers are now 'designing' in these materials. Fibreglass Ltd. have compiled a 30-page illustrated booklet to help manufacturers who are about to explore this field. An outline of the kinds of *Fibreglass* and resin available in this country is given; also a brief description of manufacturing methods and some basic technical data.

AUTOMATIC CONTROL

Chemical and Instrument Engineers Meet at London Conference

This is a report on the Joint Conference on 'Automatic Control in the Process Industries' held by the Institution of Chemical Engineers and the Society of Instrument Technology Ltd. in London last month. Some 750 people attended this conference, which was aimed at bringing about a better understanding between the instrument technologist and the chemical engineer and encouraging the essential co-operation between them in the design and operation of automatically controlled process plants. Our report includes shortened versions or extracts from the various papers and a summary of the discussion and concluding remarks.

Introduction to Conference

The Use of Control Equipment in the Process Industries

By John A. Oriel, C.B.E., M.C.
(President, The Institution of Chemical Engineers)

THE privilege of opening this discussion on the use of automatic controls in the process industries is all the greater because I hope and really believe that this also marks the opening of a new era of co-operation between the instrument technologist and the chemical engineer. It is not so very long ago that the question whether automatic control should be installed or not in a new plant was settled by the intuitive feeling of generosity or otherwise of the controller of the purse strings, and I am afraid that there still lingers in some minds the impression that automatic equipment is a luxury which may, or may not, be added at some later date. The time has, however, passed when instrumentation could be looked upon as a luxury; nowadays, with much of our plant designed for continuous operation, often with high throughput and at very severe operating conditions, the control is an essential part of the process itself, and the design of the plant is incomplete unless full account has been taken of the instrumentation.

The need, therefore, for the closest collaboration between the instrument technologist and the chemical engineer during the design, development and operation stages is of the greatest importance. The need for a complete understanding of each other's problems cannot be over-estimated.

Nor is full instrumentation a passing phase due, as is sometimes supposed, to our enjoying at present a period of full employment. It is due to the plain fact that for the efficient operation of the kind of plant we are designing today, for maximum yields and for quality control, full instrumentation is essential. This fact is appreciated in most large organisations. I have had the good fortune, throughout my working life, to be associated with an industry in which electrical, hydraulic and electronic controls have been in use for many years. The use of and the principles governing the use of automatic controls is not by any means new in most of the process industries; the word 'automation' has grown up recently, fostered, I suppose, by the sensational press which has only recently heard of this subject. I hope we shall be able to avoid too much use of it in this conference.

Smaller industries and automatic process control

It is not nearly enough that some of the larger industrial organisations should use automatic equipment; for the economic prosperity of our country a knowledge of the value of such equipment should extend to the smaller industries on which we depend so much for our export trade. The failure to make use of these developments is often due simply to a lack of knowledge on the part of management, and I hope that one of the results of this conference will be that a great and fresh interest in this subject will be spread over a wide area of our process industries. It must be recognised, too, that the trades unions are even more responsible than management for the tardy introduction of automatic control into the industries of this country; their fear of unemployment as a result of using automatic equipment amounts almost to an industrial disease. If, as is right and proper, their duty is to increase the pay packet of their members, then they should use every possible means to compel management to install equipment which will improve quality and increase production. I make no apology for introducing this somewhat contentious note; we scientists and technologists too often expose ourselves to criticism because we turn a blind eye to the social effects of our discoveries and developments.

Need for research

Turning now more closely to the object of our discussion today, the present knowledge of the relationship between the instrument and the process it has to control is largely empirical. This can only mean that a lot of tedious and unnecessary work has to be done in the design stage. Every new plant has to have its control equipment designed largely on the basis of rule of thumb. The underlying principles are woefully lacking. Much has been done towards the study of static conditions, but little is known of the characteristics of continuous operation.

This is even true in my own industry—the petroleum industry—in which continuous operation and automatic control have been common practice for many years. There is a need, a crying need, for much research on the application of existing theories and the collection of performance data, using such new tools as the process analyser. This would greatly help in speeding up and rendering more

accurate the design of our equipment.

Here, indeed, the universities may help. It is futile and, perhaps, unfair to expect them to make any real contribution towards the practical solution of our problems in industry, entirely divorced as they are, and probably should be, from the industrial world. Nor indeed are the technical colleges in a much better position. They too are not in close touch with the industrial outlook and conditions, nor concerned with the element of cost which must be of first consideration in industrial design. The universities, and particularly the technical colleges, could help in studying the necessary theories. The design and development of practical equipment will unquestionably be the work of the industries concerned. For this the chemical engineer and the instrument technologist must join hands in the task.

There is no doubt a great need for research; there is a great need for a sound theoretical basis for design, but the real immediate need that I see is for the easy and ready exchange of information and data which already exist. It is clear that in the allied field of servo-mechanisms, where the data concerning the process were readily available during the war, progress was rapid. Is it too much to hope that one outcome of this discussion will be the setting up of a simple centre where there can be a ready exchange of data which is so urgently needed by us both ?

Fundamentals of Automatic Process Control

By R. S. Medlock, B.SC., A.R.I.C., A.M.I.MECH.E., A.M.I.E.E.

(George Kent Ltd.)

Desired values of temperature, level, pressure and other physical quantities are maintained by the manipulation of valves, dampers and other types of regulating units. A complete automatic control system incorporates the plant, whose controlled condition affects the response of a detecting element. This response is measured by a measuring element and compared with the desired value. The difference between the measured and desired values is called the deviation and this is fed into a controlling unit which transmits a control signal to the regulating unit and so provides the necessary correcting condition.

The communicating arrangement of these elements is important. In an example of a conventional system, any departure from the desired value at the measuring point of the plant causes a signal to be fed to the regulating unit which in turn brings about a corrective action at the measuring point *via* the plant. The measuring point is often associated with the output of the plant and the regulating point with the ' input,' but this is not always the case, as the positions may be reversed. For example, the level of liquid in a tank may be controlled by a valve regulating either the inflow or the outflow.

The dominant feature of this ' closed loop ' type of control is the continuously recirculating action, so that a change made to any element of the loop is eventually felt by all the rest.

The individual elements in some control systems may be difficult to identify, but there is rarely any doubt as to whether the system incorporates feedback or not.

Occasionally the ' open loop ' control system is used for control of combustion and similar applications, but it has some very serious limitations. In some applications, the open loop system may be combined with the closed loop in order to reduce disturbances before they enter the plant.

On theoretical grounds it is a worthy objective to eliminate all incoming disturbances before they reach the plant. In practice, however, this approach will involve additional equipment, and may also complicate the arrangements for changing over the plant from manual to automatic operation or *vice versa*. For many applications, the best practical approach is to avoid open loops and to develop a closed loop system which has a sufficiently fast response to deal adequately with incoming disturbances.

The problem of selecting the most suitable control actions and their optimum settings is very complex and requires consideration of economic and safety factors in addition to those concerned with control technology. However, some elementary guiding principles can be given which, being of a qualitative nature, should be treated with considerable reserve.

(*a*) Plants possessing one or two major time constants which are large compared with any others in the loop are stable with the discontinuous types of control action.

(*b*) If it is undesirable suddenly to inject into a plant large floating potential corrections by discontinuous control action, floating or integral action can be used provided that the plant has essentially a single time constant which is large compared with all others in the loop. Better alternatives, which are more costly, would be either proportional or proportional plus derivative actions.

(*c*) Plants possessing two or three major time constants generally require proportional or proportional plus derivative actions.

(*d*) Plants possessing more than three major time constants often need three-term action.

(*e*) If distance-velocity lags exist in the loop, derivative action is generally omitted and proportional plus integral action is used.

(*f*) If the plant has a very small overall time constant (*e.g.* flow control) the selection of control actions and optimum settings depends on the time constants of the measuring and regulating units.

(*g*) Derivative action is rarely used when the time constant of the plant is comparable with or shorter than the time constants of any of the other elements in the loop.

The Dynamics of Process Plant

By J. McMillan, B.SC., A.INST.P.

(Imperial Chemical Industries Ltd.)

The controllability of a plant is determined by its dynamic characteristics. Frequency-response analysis provides a method for experimental and theoretical study of plant characteristics and of their effect on controllability.

The simplest elements are those producing distance-velocity and exponential lag. The dynamic characteristics of plant elements are usually interdependent and often complex, but they may approximate to those of a simple system.

In the normal design of plant for steady-state conditions many assumptions and approximations are made, mostly justified by checking theory against practical experience. In developing tractable methods for the prediction of the dynamic characteristics of plant the need for approximation remains, but the same assumptions and approximations may not be justified.

Strictly, all plant elements are distributed systems and exhibit some non-linearity. A wide knowledge of chemical engineering fundamentals and a great deal of experimental confirmation is required if the right approximations are to be made. Very

little has been done yet, but an approach more fundamental than that often adopted in chemical engineering research seems to be necessary, and the work has already drawn attention to the lack of fundamental knowledge of the unit processes.

The consideration of controllability is well justified at the design stage, even with the present state of knowledge. For example, in the design of a heat exchanger, simple controllability considerations show that a high controllability is favoured by a high value of the ratio—capacity/throughput (demand side) to capacity/throughput (supply side). A great deal remains to be done, however, before controllability can be considered quantitatively on equal terms with steady-state performance criteria.

It is still too early to know the exact nature and form of the data which the design engineer will use. The dynamic characteristics of a plant are often bound up with the design parameters in a complex manner which is not, as yet, amenable to rapid estimation. It seems unlikely that general design data will become available, but it is envisaged that general methods of prediction will be devised and no doubt these methods will be developed and simplified in the light of experience.

The Temperature Control of Large Storage Tanks

By W. A. J. Preece, B.SC.
(Shell Chemical Co. Ltd.)

This paper is concerned with a particular application of automatic control which is an illustration of the interdependence of the chemical and instrument engineers in providing the solution to a control problem.

In recent years the practice of applying automatic control to the temperature of large storage tanks, which must be maintained above atmospheric temperature, has received attention in the petroleum industry. Savings of the order of 1,000 tons of steam p.a. per tank have been obtained by applying automatic control to storage tanks of about 3,000 tons capacity held at temperatures around 160°C. This is about half the original steam requirement.

Location of the temperature element and the heating and cooling characteristics of the system as a whole are of great importance in a successful control loop. If these are given sufficient attention it has been found possible to save considerable quantities of fuel using very simple control systems.

Automatic Control of Batch Processes

By W. A. Goldstein
(Bakelite Ltd.)

Automatic control has a considerable part to play in the batch process and, although the problems involved are somewhat different from those obtaining in continuous operations, the advantages derived are the same. Generally speaking, batch and continuous processes employ the same type of control equipment except that in many instances a programme controller is used to initiate the various stages of the process, control the period of each stage and, if necessary, provide continuous variation of the control point of a particular variable in accordance with a predetermined characteristic.

The heart of many batch control systems is the programme controller in one form or another. The type of programme controller selected will depend upon the degree of complexity of the process and whether the associated control valves or other operators are all of the two-position type. All programme controllers may be linked with conventional-type instruments for automatically controlling a particular variable at any selected stage of the process.

The main weakness of many existing batch process control systems is that the control is applied on secondary variables such as temperature and pressure. Although the composition or quality of the materials being processed is available from separate analyses, corrective action is only applied indirectly. Work at present is proceeding on the development of industrial-type equipment, both for the automatic chemical analysis of materials and the continuous measurement of such physical quantities as viscosity and turbidity. When these are available in suitable form the end-points of many batch processes will undoubtedly be determined by their use rather than by the existing methods. Such instruments will be of considerable use in determining the composition of the raw materials to be used in each reaction, and the secondary variables will be set from such raw material analyses, initially by the plant operator, but eventually automatically, *via* a suitable computor mechanism.

Surprisingly little is known at the moment of the kinetics of the reactions involved in many batch processes. When this information is available it will enable the chemical engineer to give more precise information on plant behaviour under given conditions. This will then reduce the present severe limitation in the employment of computors, as it will be possible to provide an adequate programme to apply the necessary corrections for any given set of circumstances.

Automatic Control in the Steel Industry

By B. O. Smith, M.SC., A.INST.P.
(British Iron and Steel Research Association)

The open-hearth furnace and the mill reheating furnace are taken to exemplify the use of automatic control in the steel industry. In both cases, the operating variables are noted, with their effects on each other and on the process. An indication is given how these variables are metered and how the process is regulated to achieve the desired operating conditions.

A brief mention is made of rolling mills where automatic control is likely to be employed in the near future.

In considering the application of automatic control to the steel industry it must be remembered that most of the basic processes are of long standing and were brought to an adequate standard of efficiency by the skill and experience of the operators before industrial instrumentation was developed. Therefore in the examples described here, automatic control has been added to existing processes to improve efficiency. This is in contrast to other and newer industries, where instrumentation has played an essential part in making the process function.

The Economics of Process Control

By S. W. J. Wallis, M.INST.PET.
(British Petroleum Co. Ltd.)

The total investment for process control instrumentation is not always a true criterion on which to balance the capital outlay against material earnings. Present-day emphasis on increased production with a current shortage of man-power has necessarily changed the economic picture.

The advantages accruing from the use of control equipment and their effect on man-power, plant time efficiency, yield efficiency and overall improvement in product quality are discussed in this paper, and the

installed and operating costs of the instrumentation for a medium-sized refining unit are analysed.

The least publicised but very important result of the use of instruments is the effect on plant time efficiency. Revenue is earned only whilst the plant is operating, and any measures taken to ensure that equilibrium conditions are established and maintained, and physical and thermal shocks to plant equipment eliminated, will provide the longest period of 'on stream' time and, equally important, the reduction in frequency of plant maintenance and overhauls will effectively reduce the charges against that account.

Automatic Control and Chemical Engineering

By B. W. Balls, B.SC., M.I.CHEM.E. and A. H. Isaac, B.SC., A.M.I.CHEM.E.

(Foxboro-Yoxall Ltd.)

The design of chemical process plants so that best results can be obtained from automatic control by instruments has received scant attention from chemical engineers. The conventional approach to plant and process design is made in terms of material and heat balances, vessel dimensions, unit plant items and general arrangement assuming balanced or static conditions; whereas for automatic control to be successful design should be related to the dynamic response of the plant. Whilst there are considerable data available on the steady-state operation of such unit items as heat exchangers and fractionation columns, there is little knowledge of their performance under changing conditions.

Much of the design data for new projects is derived from laboratory and pilot-plant studies, but these methods give scant assistance in the assessment of the dynamic behaviour of the completed design, because of the scale factors employed. Whereas the reaction dynamics and measurement lags may not alter when a scale factor is applied in the final production plant, capacity-throughput relationships and distance-velocity lags will differ considerably.

In this paper, an analysis is made of the source, significance and identification of load changes. Problems of establishing appropriate criteria for process control and individual control loops are considered. Some means of improving plant controllability are described by considering the type of reaction, type of process and method of regulation. Indications are given for introducing controllability at the mechanical design stage.

It is concluded that there are many factors which can be considered in the design stage of a process so that best use can be made of instrumentation, particularly for complete automatic control of the process. These factors are properly the concern of the chemical engineer, who should be prepared also to obtain experimental data on plant controllability so that, eventually, a full synthesis of design and its instrumentation can be achieved. This is considered to be a necessary stage before the introduction of computers based upon final product analysis to achieve full automation.

Automatic Control in the Pulp and Paper Industry

By N. C. Underwood, M.SC.

(Bowaters Development and Research Ltd.)

The processes of the industry can be divided conveniently into three sections: the production of pulp from wood by chemical methods, the production of pulp by purely mechanical means, and the manufacture of this pulp into a continuous paper sheet.

As an example of a chemical cooking process the control of the sulphite process is described briefly.

Most of the controls used in the digestion and acid plant follow normal chemical engineering practice for recording and controlling levels, pressures and temperatures. The steam flow to the digesters is usually temperature-controlled by a cam-type instrument to give the required cooking programme. The chief difficulty is that of obtaining a representative temperature measurement for the large volume of the digester, and so a scheme has been used to control steam flow to a pre-set programme regardless of the temperature of the digester.

In the acid plant the sulphur-burning process is automatically controlled. The level of sulphur is controlled while the admission of secondary air to the burner is controlled to give a constant concentration of sulphur dioxide (usually 17%) in the gases passing to the cooler and limestone towers. Although it is desirable to maintain a high concentration of sulphur dioxide any approach to the theoretical maximum of 21% leads to raw sulphur being carried over from the burners.

Some limestone towers are now temperature-controlled and are fitted with refrigeration for summer use. Alternatively the rate of water flow is controlled for constant density of the output solution.

When a digester is emptied or blown, the gases are sent back to the towers for recovery of sulphur dioxide. The intermittent flow of recovery gas superimposed on the steady flow from the sulphur burners tends to disturb the control of the tower so that it is now good practice to provide a separate tower dealing solely with recovery gases.

Control and instrumentation is now being considered as an integral part of new papermaking processes. The difficulty is now to deal effectively with the mass of data which is produced by the instrumentation of a modern factory. We look forward to the development and exploitation of data handling systems to sort the abnormal from the normal, and to derive functions to give an overall picture of plant performance from individual installations on the manufacturing machines.

Development of Modern Control Technique and the Pattern of Future Development

By A. J. Young, B.A., B.SC.

(Imperial Chemical Industries Ltd.)

Chemical engineers who wonder why a serious gap exists between theory and practice in the process control field while the design of servo systems is so firmly based on theory, will find the explanation in the history of the development of the subject in the last 30 years or so. A vicious circle was created by the lack of experimental data on which theoretical treatment should have been based, and by lack of appreciation on the part of the practical engineer of the need for obtaining these data. The present attempt to remedy this situation comes very late in the history of process control and it is all the more urgent on this account. Also, it is very necessary at this stage to ensure that a similar gap does not develop between the plant designer and the control system designer—and it is perhaps the

main object of this conference to prevent this gap from developing.

There can be little doubt that during the next few years it will become possible to predict the characteristics of most commonly used plant equipment with a degree of accuracy quite adequate for the immediate purpose. This purpose is, of course, to make possible the design of plant which will permit the most efficient use of available control equipment—thereby lowering production costs.

It is accepted that the chemical engineer is not ready to carry out his part in industry until he has a general knowledge of the principles of process control.

At the same time, as has been pointed out by the immediate past-president of the Institution of Chemical Engineers, the development of process control and the design of control systems for exacting processes must demand specialists—the control engineers—who in their turn must have a good knowledge of chemical engineering.

It is likely, therefore, that many of the control engineers of the future will come from the chemical engineering departments of the universities and the technical colleges. The present and desirable trend appears to be for such engineers to spend several years in industry and then to take one of the available postgraduate courses in control engineering. On these courses they will no doubt find physicists, physical chemists, and electrical and mechanical engineers, and it will be most interesting to see which type of undergraduate training is most useful as a basis for the career of control engineer.

The chemical engineers who do not specialise in control still have a very important contribution to make to its development. As already implied, they must keep in touch with advances in knowledge of system design, so that these are not neglected when new plants are built. They must be sufficiently abreast of progress to be ready to apply new knowledge as soon as it becomes available.

The time lag between development and application has often been blamed for the perilously slow overall advance in industrial productivity. The lag in applying the latest information, technique and equipment in the process control field must be reduced and the chemical engineer has a direct responsibility for reducing it.

The most important lessons to be drawn from this paper, and from this conference, are the ways in which the chemical engineer can do this.

Conclusions. The trends in automatic process control appear to be towards new types of systems which will not necessarily develop from those now in use, and towards more integrated systems with considerably improved performance.

If these apparent trends are real, it is safe to predict that measuring and transmitting equipment will become more sensitive and faster in response. It will also take advantage of electrical transmission to an increasing extent.

The use of computers seems to be inevitable: first, for determining optimum operating conditions in the office; secondly, for direct use on the plant as part of the control system.

The chemical engineer can make a valuable contribution to development of process control in one of two roles: namely, as a chemical engineer responsible for process development and design, and as a specialist control engineer.

Most chemical engineers will not specialise in instrumentation, and therefore the most important conclusions to emphasise are those which can be drawn with regard to the ways in which the chemical engineer can best assist the development of process control, namely:

(1) By making sure that the latest control technique and equipment is used in each new plant designed;
(2) By taking care to provide for the additional measuring points required for obtaining plant and process data—by automatic logging devices; and
(3) By helping the control engineer to assess the economics of process operation, and the relation between operating costs and control quality.

Resumé of the Conference

By Sir Harold Hartley, K.C.V.O., C.B.E., M.C., F.R.S.

I have jotted down a few layman's comments on the papers, which I have asked Mr. Young to be kind enough to read, leaving him to sum up the discussion. However, when I came to Mr. Young's final paper I found that he had anticipated most of what I might have said, so it only remains for me to try and dot a few 'i's' in his summary of the present position and his forecast of future trends.

Let me first congratulate the organisers, and especially Mr. Samson and Mr. Isaac, on their success in assembling a series of most interesting and instructive papers arranged in logical order which give such a coherent and consecutive survey of the whole field. I am sure that many like myself will have found them of great value in helping to clarify our ideas as to the part which automatic control is likely to play in the process industries.

Mr. Medlock's paper started us off well by presenting the basic principles of control very concisely and clearly and by defining the terms in general use. If he will forgive me for saying so, the absence of mathematics reminded me a little of 'Reading Without Tears.' Not that mathematics should ever be a source of tears to an engineer, be he chemical, control or otherwise, for mathematics is the fundamental technique of all engineering. But I should like to reiterate what Mr. Young has said about the unfortunate rift between mathematical theorists and control engineers in the past, and how important it is that all those concerned with the applications of control in the process industries should be able to apply mathematical theory to the quantitative approach to their problems. This must be the common ground between the chemical and the control engineers. In this connection let me remind you of the rapid progress made by the Soviet Union in the application of automatic control based on her massive contributions to its mathematical theory.

The papers by Mr. McMillan and by Mr. Balls and Mr. Isaac present an interesting contrast and a timely reminder not to let 'the best be the enemy of the good.' Much has already been accomplished in process control by qualitative methods, though it is noticeable that the progress so far has been mainly in the control of physical rather than of chemical factors, since the knowledge of their dynamic characteristics is more readily accessible. The dependence of controllability on an exact knowledge of the dynamic characteristics of the components of both the machine and the control mechanism is illustrated particularly well in Mr. Underwood's paper by his example of the speed stability of a paper machine which is maintained to 0.1% over a range of zero to full load.

Mr. McMillan emphasises the need for a much closer study of the dynamic

characteristics of processes and their reactions to disturbances, as opposed to their steady-state characteristics which have hitherto been the main preoccupations of the research chemists. Mr. Young, in his presidential address to the Society of Instrument Technology, has given us a most instructive diagram showing how the investigation of these dynamic characteristics simultaneously in the laboratory and on process plants can ultimately contribute to quantitative theory which can be made the basis of design jointly by the chemical and control engineers. Success will depend on their close association at all stages and by their mutual appreciation of one another's problems.

However, the possibility of determining the dynamic characteristics of existing plants, an essential element in the solution of the problem, is only made possible by the existence of the present instrumentation and control mechanism. Mr. McMillan has described one method of quantitative analysis by means of sinusoidal variation of input. He describes the step-response method as only qualitative, but Dr. Rosenbrock described in a recent paper to the Institution of Electrical Engineers a simple method by which it could yield quantitative results. There is, too, the method, used mainly, I believe, in America, based on the analysis of the normal fluctuations of plant operation, if the logging of the instrumentation is sufficiently detailed and accurate for the purpose. I trust that all plant operators will be fully seized of the ultimate advantages that will accrue from the introduction of disturbances which it is their normal duty to avoid.

Mr. Goldstein, in his paper on the automatic control of batch processes, introduces the more difficult problem of the control of a sequence of transient conditions. The ultimate solution may lie in the continuous measurement of the conditions with an electronic computer to calculate the adjustments that are required as, for example, in the controlled flight of a long-range rocket. Mr. Young, in his paper, referred to self-optimising systems which are another example of the same type of control. But there may be a vast difference in cost between these ideal self-sensing systems and some simpler method which will meet the commercial needs of the plant in question. Here Mr. Wallis's realistic paper on the economics of control brings us down to earth again with his overall picture of the capital, operating and maintenance costs of instrumentation, and his emphasis on the need for skilled staff and workshop facilities to service the control equipment. The justification for automatic control depends on its cost and the contribution it makes to the economy of operation by savings in operating costs, by improved quality of the product, by higher availability and utilisation of plant and greater safety. Mr. Young has referred to the need for new types of analytical instruments for the rapid determination of plant product composition, when product quality is the objective. All this ties in with the need expressed by several authors for more detailed knowledge of the chemical kinetics of the process. Rapid developments are taking place in the instrument field, such as the infra-red spectrometer with the ingenious Merton grating which has added so much to its accuracy, Barker's square-wave polarograph which attracted so much attention at Geneva by its great potentialities, and the Harwell development of the sonic analyser for gases.

But control of product quality might easily become a catchword unless its economic significance is examined in relation to the commercial value of higher purity, either in the higher selling price of the final product or in the higher process value of an intermediate. In some cases the value depends on performance, *e.g.* the anti-knock rating of gasoline. Possibly another joint conference might be devoted to a closer analysis of product quality and the instrumentation needed to control it, as the two are so closely allied.

Most of the authors have drawn attention to the shortage of useful data on the dynamic behaviour of process units and Mr. Oriel suggested the setting up of a centre which could act as a clearing house for such data as they accumulate, so that they would be available to all concerned. This is one of the most useful functions which would be served by the chemical engineering research laboratory recommended four years ago in the Cremer report. The collection and classification of such data at one point would be a great economy and would reveal the gaps where more research is required. It should be equipped with an electronic computor which would be available to industry for the analysis of the experimental data.

In the design of machines and servo-mechanisms when the dynamical characteristics of both are accurately known, the electronic simulator has proved itself a most valuable ally. I venture to predict that the day is not far off when a simulator designed for the study of process control will become a necessary piece of equipment in a national chemical engineering research laboratory.

However, I must not close my remarks by this reference to what some of you may have come to regard as my favourite red herring. Let me end by expressing the hope that this joint meeting of the Society and the Institution will be the first of many, as it must have contributed so much to a better understanding between the chemical engineer and the control engineer as to the part which each has to play in their common task.

Discussion and Conclusions

The chairman at the morning session was Mr. J. F. Coales, O.B.E., who is lecturer in charge of the postgraduate course in control engineering in the engineering department of Cambridge University. The chairman at the afternoon session was Dr. N. E. Rambush, chairman and managing director of Power-Gas Corporation Ltd. and vice-president of the Institution of Chemical Engineers.

During the discussion, several speakers stressed the importance of economics in applying automatic process control, and among the other chief points touched upon were the rôle of mathematics in control engineering; the relationship between the automatic control and servo-mechanism fields; frequency response analysis; quality control; and labour relations.

The resumé of the conference was to have been given by Sir Harold Hartley, past president of the Institution of Chemical Engineers, and Mr. A. J. Young, who is president of the Society of Instrument Technology. Sir Harold was unfortunately called away from the conference and his resumé was read by Mr. Young. This resumé appears above.

Mr. Young then added his own brief comments to those of Sir Harold. He pointed out that the main points to be studied when considering a process control system were: economics (this was the keyword); specification of the requirements of the plant; the control quality required; and the design of the system.

To design a system, he pointed out, you must have a knowledge of the mechanism of the process.

Mr. Young pointed out the danger of misunderstanding the rôle of response analysis, which was merely a method of checking theoretical calculations.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

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Treatment for crusher bearings

Crushers are some of the hardest worked and least attended pieces of machinery in industry. A hard safety skin is provided for bearings, pins, etc., by a product marketed under the name of *Molykote*, which, it is claimed, eliminates pick-up and other troubles during running in, and in many cases overcomes the detrimental effects of slight misalignment (although the product is not intended to be the answer to misalignment).

The makers of *Molykote* cite, as an instance of its application, a crusher break-down which threatened to have a serious effect on production in a London gas works. The machine in question was a 36 in. × 36 in. single-roller coal breaker. There is a possibility that the two frames were slightly out of alignment; this had caused considerable trouble to the two $2\frac{3}{4}$-in. diameter × 10 in. long cracker plate bearings, which, although being mechanically greased, ran hot after a few minutes' operation and had to be additionally hand greased several times per hour.

These cracker plate bearings had seized up. They were badly scored and slightly twisted. The $2\frac{3}{4}$ in. diameter shaft was also badly scored.

The two bearings were taken from the scrap heap, their badly scored running faces were degreased, and a thin layer of *Molykote* M.88 was applied. They were then left on the radiator in the foreman's office.

The next morning a smear of *Molykote* G was applied to the bearings. Into the shaft—after degreasing—some *Molykote* Z powder was rubbed, after which *Molykote* G was smeared on and rubbed in. No burrs were removed and the bearings were reassembled, the shaft not having been taken out of the machine.

The crusher was started up and the two treated cracker plate bearings operated satisfactorily; there appeared to be no increase in temperature even after all the other bearings had warmed up.

The cost of the *Molykote* compound used was under £4; owing to prevailing conditions, more was used than was really required; it is estimated that about half of it went on the floor. Altogether, 3 oz. of Z, 3 lb. G, and approx. 2 oz. of M.88 were used.

A set of bearings cost £24; the mechanical engineer estimated that at least 48 hr. would have been required to get the crusher into operation again. It is not known what the cost of a new shaft would have been, but an estimate puts the total repair cost at £70 to £90.

The bearings were still running satisfactorily after four weeks, ordinary grease being used for lubrication.

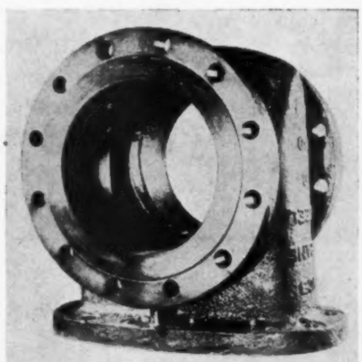
CPE 101

Chemical nickel plating

As was briefly reported in our October issue, the *Kanigen* process of chemical nickel plating will be available in the United Kingdom in 1956. The chemical process depends on the catalytic reduction of a nickel salt by a hypophosphite:

$$NiCl_2 + NaH_2PO_2 + H_2O$$
$$\rightarrow Ni + 2HCl + NaH_2PO_3.$$

Metals which catalyse this reaction begin to be plated as soon as they enter the plating bath, while others must be touched with one of the catalytic metals in order to initiate the reaction. Once the reaction has been started in this way it will continue to be catalysed by the nickel which has been deposited.



This 10-in. cast steel valve body has been plated with 2 mils of 'Kanigen' plate.

Among advantages claimed by the makers are perfect coverage and plate uniformity; the ability to plate many articles by simple immersion in baskets, since no electrical contact is required for the process and racking and wiring are eliminated; the ability to plate difficult materials; and superior physical properties. The makers further point out that, when planning articles for coating with *Kanigen* plate, design engineers are subject to few of the restrictions imposed on them when using electroplating processes. Particularly important is the fact that there is no need to allow for the poor throwing power of most electroplating solutions in order to obtain a uniform deposit. It is not necessary to arrange for jigging or unsightly contact points. Care must, however, be taken to ensure that the plating solution can reach all parts which require plating.

Applications. The applications in

which *Kanigen* plate is of importance can be divided into three groups:

(1) *Corrosion resistance.* This is possibly the largest field of application for *Kanigen* plate, which has a higher resistance to corrosion than either wrought or electroplated nickel. It is often possible to save the expense of using stainless steel by applying a coating of *Kanigen* plate over steel or aluminium. It is claimed that considerable savings can be made on parts which are difficult to fabricate, such as pipe fittings and valves. Typical applications include valves, pipes, pipe fittings, pumps and filter parts for use in chemical processes; compressors; steel balls for heat transfer surfaces; reaction and storage vessels; extrusion press screws; drum drier rolls; and screw conveyors.

(2) *Wear resistance.* The hardness of the plate can be greatly increased by heating.

(3) *Reclaiming of parts.* The plate is useful for building up parts which have been worn or machined beyond acceptable tolerances. Owing to the uniformity of the plate it is often unnecessary to grind or machine the part after coating.

Properties. The properties of *Kanigen* plate may be summarised as follows :

Composition about 91.5% nickel and 8.5% phosphorus.
Melting Point 890°C.
Electrical Resistivity about 60 microohm cm.
Coefficient of Linear Expansion 13×10^{-6} per °C.
Thermal Conductivity in the range 0.0105 to 0.0135 cal./cm./sec./°C.
Specific Gravity 7.9.

The thickness of *Kanigen* plate can easily be controlled to within $\pm 10\%$ of the average, irrespective of the complexity of the part being plated.

CPE 102

Air-supplied mask for noxious atmospheres

An air-supplied mask, for use in all operations in atmospheres containing noxious fumes and dust, is said to be sufficiently light and comfortable to permit wearing for a full 8-hr. shift, with minimum restriction on mobility.

The visor is moulded in rigid transparent PVC and affords an unobscured vision through 180°—*i.e.* 90° either side of centre line. The window, in *Cobex* PVC copolymer, is fitted in a rubber grommet and is easily renewable. The mask rests on the back of the head during all normal working movements and the cape is designed to avoid any backward drag when bending or stooping. The control unit is fitted on waistbelt at back with two outlet branches leading over each shoulder to central entry on visor, at point below wearer's chin, with an interior baffle to give fan-shaped diffusion over window and wearer's face. A flexible PVC loop is fitted on crown of mask to facilitate removal and storage with minimum of handling.

Air-supplied mask.

The mask is normally supplied for use on mains pressure at from 15 to 30 p.s.i. and fittings can be supplied for use on compressors at from 5 to 10 p.s.i. It is also intended to supply a regulating valve calibrated to provide an air flow of 6 cu. ft./min. maximum and ½ cu. ft./min. minimum at 20 p.s.i.

The following *Compton* portable air compressors are recommended for use with the plus-pressure mask and can be supplied by the makers:

Type 2D 625: output 4.5 cu. ft. of free air per min. at 10 p.s.i. pressure. Sufficient for one mask.

Type 15D: output 15 cu. ft. of free air per minute at 20 p.s.i. This is sufficient for three masks or one man using mask and air-supplied suit.

Mask, waistbelt and control box assembled ready for use range in price from £10 7s. 6d. to £12 5s. 0d.

CPE 103

Heavy-duty screens for wet and dry operation

A new range of heavy-duty, two-bearing, vibrating screens has been introduced for the screening of dry or wet sand gravel, crushed stone, ore, coal and for many industrial applications. The range includes single, double and triple deck models with screen sizes, 8 ft. × 3 ft., 10 ft. × 3 ft., 10 ft. × 4 ft., 12 ft. × 4 ft., and 12 ft. × 5 ft. According to the makers, this type of screen can be used for finishing screening of all sizes of aggregate and sometimes for scalping service where the oversize to be handled is not too large or too heavy. However, they recommend their heavy duty scalpers for scalping service.

Because of the robust nature of the work to be carried out with the new screens, the toughest alloy steels and the finest anti-friction bearings, which are provided with adequate protection are used, the makers state. The main frame, horizontal for rigidity and ease of installation, is made of heavy channels or I-beams, securely welded and reinforced with gussets and angles. The vibrating frame of heavy steel side plates is reinforced longitudinally with angles which also support the screen cloth trays. It is stated that perfect alignment is ensured by angles and end plates and the vibrating unit through the centre.

The entire vibrating mechanism, including vibrating unit and screen cloth, floats on springs. The vibrating unit itself is mounted on two heavy-duty roller bearings and is equipped with two enclosed and automatically adjusted counterweights which prevent the screen 'jumping' at critical speeds and ensure smooth operation. The resultant vibration which is constant under light or heavy loads is intense and circular in motion and is uniform on all parts of the screen cloth.

Steel screen trays or rubber protected steel screen supports over which the screen cloth can be stretched are optional equipment. Alternatively, one deck can be furnished with a tray mounted screen cloth and the other deck or decks with stretched wire cloth to suit customers' requirements.

When used in washing plants for rinsing stone or gravel special spray pipes can be fitted; the makers state that these, being firmly attached to the screen frame, cannot interfere with or dampen efficient operation of the

screen. Special nozzles are provided to deliver a uniform, pre-determined amount of water providing the pressure is kept constant, over the whole screen surface. The new screens are recommended for use prior to 'Super-scrubbers' and after rotary washing screens and 'Super-scrubbers' to separate and rinse the various sizes of aggregate and for use where aggregate specifications require the stone to be rinsed with water to eliminate dust or a small quantity of dirt.

CPE 104

Emulsifier

An entirely new anionic type of emulsifier, *Polamine*, is stated to be based on properties not previously exploited on a commercial scale and is particularly intended for making liquid oil-in-water emulsions. It is claimed by the makers to be a very powerful emulsifier producing extremely stable emulsions of very fine particle size.

It is stated that generally speaking, no costly machinery or heat need be employed, since in many cases emulsification is spontaneous. Some emulsions can, however, be improved by homogenisation.

The analysis of a typical batch of *Polamine* is given as follows: acidity as oleic acid, 0.1%; drop point, 112°C.; saponification value, 8.4; iodine value, 18.

The material is cream-coloured, pasty, of slightly granular appearance, and with little odour. The makers state that it can be employed quite widely for the production of numerous types of emulsions including mineral oil, castor oil, olive oil, lanolin, petroleum jelly, etc., while it will also easily emulsify solvents such as solvent naphtha, xylol, white spirit, petrol and trichlorethylene.

It is further stated that *Polamine* is of particular value in the manufacture of oil-in-water emulsions as it lowers interfacial tension to negligible values when present at oil/water interfaces. The emulsions produced are very stable and of low viscosity. Emulsions made with *Polamine* are resistant to some degree to electrolytes and, in fact, emulsification is enhanced in some cases if salt is present up to a certain predetermined safe maximum (above which the reverse effect becomes obvious).

The emulsifying power of *Polamine* is at its highest at low temperatures (20°C.) and at its lowest the nearer to 90°C. emulsification is carried out.

CPE 105

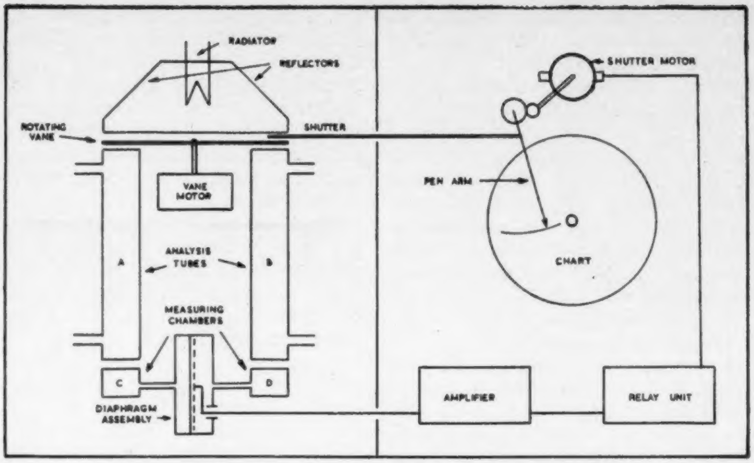


Diagram showing principle of 'Null' balance recorder.

Instantaneous and continuous gas analysis by infra red spectra

There are not many methods for the continuous measurement of gas concentrations, and, of those tried, most have not been truly 'specific'—they have given false alarms by their inability to distinguish exactly between the gas they were designed to measure and some other possible constituents of the mixture. The method of detecting and measuring the concentration of a gas by recording its 'optical' absorption in the infra red spectrum eliminates this possibility.

In this kind of spectroscopic measurement no reagents are used, and no change is made in the gas tested. The mixture is continuously examined by being drawn through a tube down which infra red radiation passes. The tube is isolated, there is no risk of explosion, and the measurement can be made at pressures other than atmospheric.

The problem of continuous spectroscopic measurement, especially in the infra red, would be very difficult to solve if dispersion of the spectrum were necessary. It is made simple in the present method by isolating the desired portion of waveband radiation through the use of a highly selective detector, which responds *only* to the absorption band of the gas being sought.

The gas to be analysed is passed through a small tube (marked A in the accompanying diagram), fitted with windows of material transparent to infra red radiation, and the absorption in the gas specimen tube is compared with the absorption in an exactly similar tube (B) filled with dry air. The energy from a hot filament is passed through both tubes (which are mounted side by side), and the portion of it transmitted through the tubes is received by two measuring chambers (C and D), both of which contain a pure sample of the gas to be measured.

These two gas-filled chambers are in pressure connection together, being separated by a thin diaphragm which forms one electrode of a small electrical condenser. The radiation transmitted through the analysis tubes is absorbed by the pure gas in the two measuring chambers, causing an increase in temperature and therefore in pressure; and if the transmission through the two paths is identical the diaphragm separating the measuring chambers remains stationary. On the other hand, when a sample of gas which absorbs infra red radiation is introduced into the analysis tube, the transmission through the two sides becomes unequal, and the diaphragm undergoes a displacement, returning to its normal position when the radiation is cut off. As this can happen only when the wavebands absorbed by the gas tested are those to which the detector is sensitive and, as the dectector consists of a pure sample of the gas to be measured and will be affected only by the complete or partial removal of the frequencies absorbed by itself, the resolving power of the device is complete, and the presence of gases in the mixture other than the one it is desired to measure will not affect the final answer.

The displacement of the diaphragm

produces corresponding changes in the electrical capacitance of the condenser. By applying a polarising potential to the condenser these capacity changes are converted to current changes, which are amplified to provide an indication which is directly related to the pressure differences between the two measuring chambers when receiving radiation.

In order to make the measurement free from zero drift, a rotating vane interrupts the radiation from the hot filament, allowing it to fall simultaneously on the two chambers of pure gas, and, in turn, cutting it off from them simultaneously, the whole performance taking place at a low frequency of a few cycles per second, allowing the pressure changes to be directly related to the temperature changes, which are themselves related to the difference in absorption of radiation between the tube containing the gas mixture being analysed and the tube containing dry air.

The essentials of the system are shown in the diagram. The same optical arrangement is used with two different types of instrument. Both models can be made for a wide range of concentrations and for almost any gas. Among the commoner gases, the following are the concentration limits: CO_2, N_2O, 3 p.p.m.:CO, C_2H_4, 10 p.p.m.: CH_4, C_2H_2, C_2H_6, 20 p.p.m.

Details of other measurements, such as sulphur and nitrogen compounds, more complicated hydrocarbons and organic vapours, are available from the manufacturers.

Applications. Among the many applications with which this method of gas analysis can deal are the following:

(1) Detection and alarm of toxic or explosive atmospheres. (CO, CH_4, organic vapours, etc.).

(2) Research on respiratory function. (CO_2, CO, N_2O, C_2H_2 and anaesthetic gases).

(3) Detection of leaks in various articles, and in gas pipe systems. A complete leak detection and measurement system is founded on the use of the infra red gas analyser.

(4) Process control in the chemical and petrochemical industries. (CO, CO_2, SO_2 and hydrocarbons).

(5) Measurement of the products of combustion (gas, oil, and solid fuel appliances). (CO, CO_2).

(6) Ventilation study and control. (CO_2, CO, CH_4, etc.).

CPE 106

Fume control cabinet

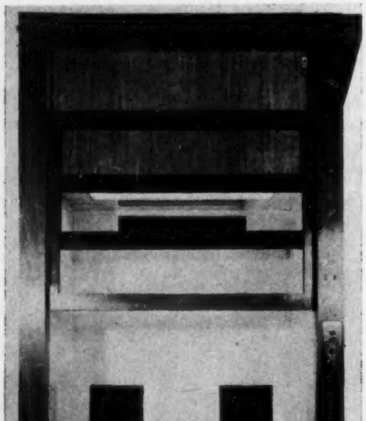
A new type of fume cabinet for handling aggressive chemicals has been designed primarily for handling radioactive compounds.

The main features of this cabinet are the PVC lining of all interior surfaces, a louvred bottom and top fume extract, a water spray fume scrubbing chamber at the rear of the cabinet, automatic sash control, interior lighting. The frame and external surfaces are constructed throughout in best quality timber. The fan is one of the *Turbro* series of PVC centrifugal fans. The fume scrubbing chambers and ducts are manufactured from rigid PVC, the scrubbing is performed by a series of water jets into which neutralising agents are added.

This cupboard will be of particular interest to chemists using the Kjeldahl digestion apparatus, also hydrofluoric acid, hydrochloric acid, perchloric acid, nitric acid, sulphuric acid, etc.

In handling radioactive isotopes ease of decontamination is essential because extremely small traces of radioactive substance may be hazardous, it is necessary that the working surfaces should not be porous, absorbent or rough.

The cabinet is lined with lead foil and faced with $\frac{1}{8}$-in. white *Cobex* rigid vinyl sheet. Three vent grilles carry the fumes and particles, etc., to a common scrubbing unit situated at the rear of the cabinet; here the fumes are 'bombarded' with water sprays, and neutralising agents, after which they pass vertically to a mist eliminator and filter, through the fan to atmosphere.



Fume cabinet.

The waste water from the scrubbing duct is carried in PVC or polythene waste pipes to settling tanks. The sash is lowered and raised with a 'dead man' safety switch—the sash is built up from rigid PVC and armoured glass.

The sizes of the cupboards vary from 3-ft. standard units to 15-ft. composite units.

CPE 107

Protective treatment for wood and cardboard

A new compound, *Redicon M*, is used if the objects to be treated (wood, paper, cardboards and fibre board) are to be protected from burning. The makers state that the compound has at the same time an excellent protective effect against attacks by dry rot and wood-destroying insects. It raises timber, plywood and hardboard to Class 1 for 'Surface spread of flame' (British Standard Definitions No. 476/1953).

It is claimed that full and permanent protection against flame and a preventive action against dry rot and insects is obtained with two coats or two sprays of *Redicon M* solution or hot and cold dippings if the total absorption of *Redicon M* amounts to 150 g./sq. yd. of treated surface. In spraying, the quantity to be applied has to be increased by about 25% to balance the unavoidable spraying losses. The composition covers 45 sq. yd. per gallon.

For the dipping process which may be applied to cut-up but not yet built-in timber as well as to woodwork, cardboard, waterproof glued plywood or to waterproof cellulose-containing fibre board, a *Redicon MS* is used. This fire retarding chemical composition is claimed to have excellent wetting properties.

Protective goggles, gloves, etc., are not required during the operation since *Redicon M* has no reaction on the skin.

Woodwork coated with boiled oil, oil paint, varnish or still relatively fresh tar oil paint, cannot be treated effectively with *Redicon M*. Even after washing out the coat, the treatment will, as a rule, not be fully effective and not offer a good appearance. If stone, xylolith and linoleum floorings, window panes, oil and varnish coatings are spattered with the composition, they can be cleaned with water.

Since *Redicon M* has excellent

wetting properties, wood dusting is superfluous. Electric motors, switches, plugs, distributors, electric light fittings, etc. have, as usual, to be covered up several times with paper or the like for preventing any possible short circuit.

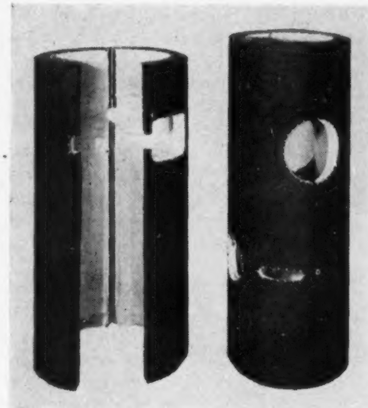
A correct *Redicon M* treatment may be recognised as follows: If small wood chips are taken from the surface, of the treated and dried woodwork and kept over the flame, they should not burn, but char superficially at the most. The yellow colour of *Redicon M* was chosen with a view to visualising the treatment performed.

If the *Redicon M* treated wood has dried well, decorative coats of boiled oil, oil paints, lacquers and varnishes can be applied. Exceptions are paints containing alkaline agents including zinc oxide, zinc oxide colours and chalk; also nitrocellulose lacquers, emulsion colours or water wax stains are not convenient.

CPE 108

Electric heating and lagging for pipes and columns

The *Isojacket* consists of flexible heating panels woven from glass yarn and insulated electric heating elements, which are backed by $1\frac{1}{2}$ to 3 in. of glass wool for thermal insulation and enclosed by cylindrical sheet metal casings which are stove enamelled. Thus, the *Isojacket* is a robust heating unit hinged for easy application and fastened by spring toggles. For larger dimensions it is also made in two separate semi-cylindrical sections which are bolted together. Cutouts can be provided in accordance with individual requirements, as shown in the illustration. The standard units are suitable for temperatures up to 400°C. (750°F.). These jackets can also be made for curved pipes. Terminal boxes are fitted to the metal enclosure which provide for $\frac{3}{4}$ in. conduit entry on units up to 30 amp. loading and 1 in. conduit entry on units for higher powers. The heating elements can be split up into several circuits up to 2,500 w. each and either lateral or vertical heat gradients can be provided.



Heating jackets.

For flameproof areas, type FJM use special heating elements (which are metal-sheathed mineral insulated resistance wires) fitted to the glass cloth heating surface and terminated by flameproof glands, screwed into flameproof terminal boxes with $\frac{3}{4}$ in. conduit entry. For temperatures up to 200°C. (392°F.) copper sheath is used (type FJM-C). For higher loadings (FJM-3 to 7) stainless steel metal sheath is employed which withstands temperatures up to 600°C. (1,110°F.). The makers point out that, apart from the use in flameproof areas, this type of jacket has also the advantage that it is very robust and impervious to moisture.

If the metal cover is not desired, *Isojackets* type IJL are available which have a glass cloth cover instead, and are available from 12 in. to 36 in. in length and 1 in. to 12 in. diameter, suitable for temperatures up to 250°C. (480°F.). Their loading is 100/150 w./sq. ft. The IJL type jackets can also be combined into special assemblies. They open axially and are fastened by metal bands. For use on glass columns, they can be provided with inspection windows.

Whilst the types described above are designed to run at black heat, metal-cased *Isojackets*, type QJM, are produced for high power/high temperature applications. For these appliances quartz yarn (96% SiO_2) is used instead of glass yarn so that the *Isojackets* withstand temperatures up to 800°C. (1,470°F.).

Heat input for *Isojackets* is controlled by energy regulators, variable transformers or automatic instruments. For flameproof areas, switches and energy regulators are available in flameproof housings or automatic intrinsically safe installations.

CPE 109

CARBON REMOVAL IN RE-HEATING FURNACES

A soot and sludge remover has recently been successfully used to reduce carbon accumulation on burner nozzles by 70 to 80% in re-heating furnaces.

The remover, *Xzit* S.S.R., was used in the forging department of Tubes Ltd., where the accumulation of carbon around the heavy fuel oil burners in the re-heating furnaces had been causing trouble. The remover was added to the fuel oil over a period of several weeks. There was a reduction of 70 to 80% in the accumulation of carbon, resulting in longer life for the brickwork, cleaner burner tips and improved atomisation. This reduction in carbon considerably reduced the time normally required to clean out the furnaces. The tanks and lines were also cleaner as any sludge present in the fuel oil was brought along to the burners and consumed in the furnace. **CPE 110**

Testing hardness of water

Testing the hardness of the water is an essential preliminary operation where water-softening plant is employed. In some instances the actual hardness does not remain constant but varies from time to time, necessitating further adjustments for effective working. A set for testing hardness and alkalinity that has now been developed comprises two automatic burettes, complete with reservoirs for Wanklyn soap solution and N/50 sulphuric acid respectively. Two each of the following are included: porcelain titrating basins, dropping bottles and stirring rods, also a shaking bottle and graduated cylinder. All these are fitted in a portable wooden case with carrying handle, lock and key. A supply of chemicals comprising soap solution, standard acid, methyl orange and phenol phthalein is also provided.

It is stated that the solutions are kept free from dust, evaporation and contamination in both reservoir and burette. Merely by pressing and releasing the air bulb, the burette is filled and the solution automatically adjusts itself to the zero mark. The equipment saves a considerable amount of time and trouble by preventing errors, it is claimed, and has an additional advantage of occupying small space in the laboratory.

CPE 111

Nitrogen plants

A range of small liquid and gaseous nitrogen plants is being marketed by a British company. The plants are high-pressure single-column units, as shown on the accompanying flow sheet. After the first stage of compression the air is passed to a caustic soda scrubbing tower for the removal of carbon dioxide. It then traverses the vortex separator for the removal of any entrained caustic solution before it is further compressed in the subsequent stages of the compressor.

After the final stage of compression the air is passed through the after-cooler, the moisture and oil separator and through one of two activated alumina driers which are worked alternately. The pure dry air then enters the separation unit and is cooled to a low temperature in three heat exchangers in series.

In the first exchanger (the pre-cooler) the air is cooled in counter current with revert gas from the third exchanger; in the second exchanger (the Freon evaporator) it is cooled by evaporating Freon 12, and in the third (the main exchanger) it is finally cooled in counter current with the revert gas from the column. In the case of the N-1 plant producing gaseous nitrogen only, the Freon evaporator operates only during the start-up period.

The air is then expanded through the throttle valve with consequent temperature drop and partial liquefaction and introduced into the base of the column which works at about 3.5 kg./sq. cm. The vapour rising in this column is continuously enriched with nitrogen by the liquid reflux and reaches the top of the column as almost pure nitrogen.

In the case of the R-1 and R-2 plants for liquid nitrogen, the vapour is completely condensed, part being drawn off into the liquid nitrogen storage vessel in which the pressure is substantially atmospheric, and part being used as reflux for the column.

In the N-1 plant for gaseous nitrogen, that part of the nitrogen which is not required for reflux in the column is withdrawn as product and warmed up in the main heat exchanger and the pre-cooler.

In all the plants a mixture of liquid and vapour enriched with oxygen is withdrawn from the base of the column through a throttle valve and passed to the shell of the condenser which works at about 0.2 kg./sq. cm. The evaporation of this liquid provides the necessary cold for condensing the nitrogen in the tubes of the condenser. The evaporated liquid leaves the separation unit *via* the main exchanger and the pre-cooler and is thereby warmed up to room temperature.

After leaving the unit part of this gas may be passed through the reactivation heater where it is heated to 250°C. and through the drier which is being reactivated. The same heater may be used to dry or to thaw out the separation unit when necessary.

When cooled down the R-1 and R-2 plants provide liquid nitrogen of 99.9% purity at the net rate of 8 and 24 l./hr. respectively. allowing for normal transfer losses between the plant and the customer's storage vessels. The N-1 plant delivers up to 24 cu.m./hr. of 99.9% gaseous nitrogen. The start-up period in each case is rather less than 2 hr. from room temperature conditions and 1 hr. after an 8-hr. shutdown.

CPE 112

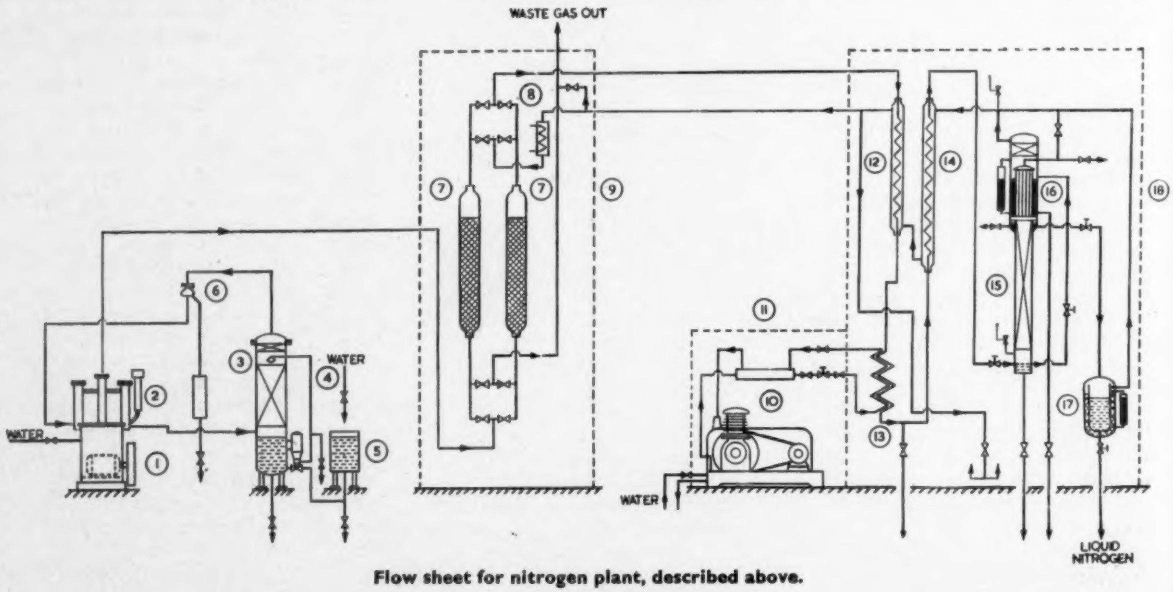
Rubberised floor paint brightens factories

The growing realisation that colourful surroundings stimulate output is resulting in increased attention to attractive colour schemes for factory walls and ceilings. Unfortunately, the factory floor, perhaps the largest visual area meeting the worker's eye, is too often overlooked.

A hardwearing rubberised floor paint is now being marketed in a range of eight attractive colours. A two-coat application gives a new lease of life to concrete, lino or wooden floors both exterior and interior. The makers state that *Factron* rubberised floor paint is easily applied by brush or spray and can be painted direct on new concrete, dispensing with the customary neutralising treatment. It is also resistant to chemicals and will give protection from mild acid and alkali attack.

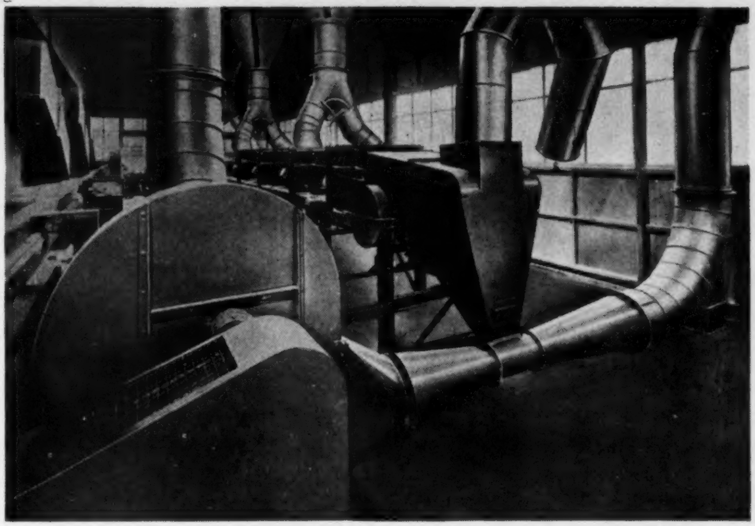
When dry, the painted surface can be washed or polished and this coating is claimed to withstand the heaviest foot traffic. It has been specially compounded for use in factories, etc.

CPE 113



Flow sheet for nitrogen plant, described above.

PNEUMATIC TRANSPORT AND DUST EXTRACTION



The pneumatic transport of solids usually entails high capital and running costs, even with a well designed system. These costs can be excessive in dust extraction and collection installations where the volume of contaminated air that has to be entrained into a plenum system to ensure satisfactory ventilation far exceeds the volume of air required for the pneumatic transport of the particulate matter suspended in the entrained air.

However, dust extraction systems are available where the collected dust has to be conveyed an appreciable distance to the final disposal point, in which this tendency has been mitigated to some extent by siting the dust separator as near as possible to the area of extraction and employing an independent pneumatic transport system to carry the dust to the disposal point. The collected dust is fed into the secondary system by means of a venturi throat. Only the minimum amount of air necessary to prevent dust settling in the ducts is used and this is much less than the volume of air originally entrained, resulting in savings in power and capital costs. Furthermore this air can be drawn from outside the building and is therefore clean, thus avoiding wear and abrasion on the fan impellor.

The accompanying illustration shows collected dust being conveyed from cyclone cone exits to the pneumatic transport system via the venturi.

CPE 114

Control valve for very low temperatures

A new control valve is designed for controlling flowing media at temperatures down to 200°C. It was developed for the low-temperature separation of hydrocarbons by liquefaction and its use has been extended to the handling of liquid air, liquid oxygen and liquid nitrogen streams in fractionation processes as well for other liquids flowing at very low temperatures. The V.S.B. valve, as it is called, employs a self-aligning diaphragm motor. The motor and mounting can be adapted to suit the various types of cold box design used to insulate different processes. The valve is normally constructed in austenitic stainless steel and is available in sizes up to 16 in. with straight-through or angle-type bodies and may be used with working pressures up to 600 p.s.i.

The design of the V.S.B. valve makes use of a stainless-steel sleeve to surround the valve. This sleeve holds the gland at atmospheric temperature and insulates it from the body of the valve. Thus, according to the makers, icing of the gland is effectively prevented with the minimum low temperature loss. It is further claimed that the performance of the valve is unaffected by extreme low temperatures and exact positioning is ensured under all conditions.

CPE 115

'Stabilflo' valve.

Impregnators

A redesigned range of plants is available for the impregnation with varnish or resin, under alternative vacuum and pressure, of electrical coils, transformers, complete electronic circuits, etc. The impregnators can also be used for a number of other purposes, including the impregnating of lead pencils with wax, the impregnation of graphite electrodes, timber and fibre board and the sealing of porous castings.

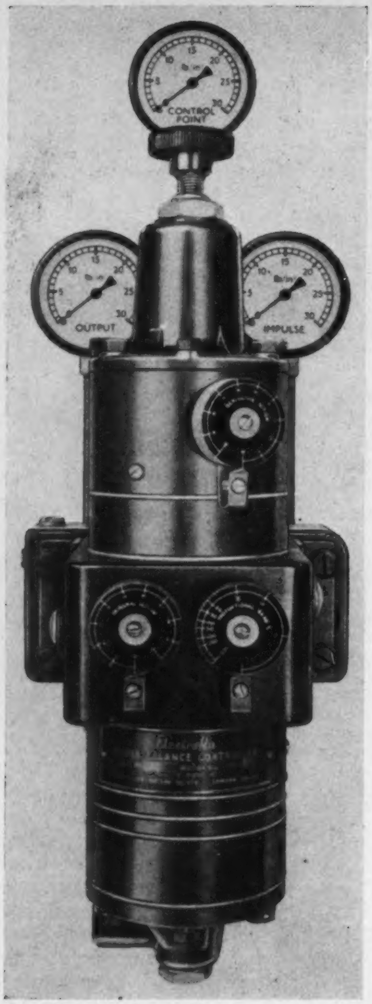
The basic design comprises a high-vacuum pump, a control panel and either one or two autoclaves and storage chambers. In the new range of models all controls have been centralised and control has been made so easy that the plant can be operated by either a semi-skilled or a disabled person.

A feature is that all pipelines are easily demountable, so that, in the event of materials getting into a pipeline, the latter can simply and quickly be stripped and cleaned. The entire pipeline is 'floating,' ensuring that vibration from the pump is not transmitted to the pipeline and the risk of fracture is eliminated.

Units are supplied either single or double, *i.e.* with either one autoclave and one heating chamber or with two autoclaves and heating chambers.

CPE 116

(18)



'ELECTROFLO' CONTROLLER

Shown above is the series 3,000 air-operated controller, a 'stack type' employing the force-balance principle for single-, two- or three-term control. The makers state that this type of controller is extensively used for the control of process variables in continuous plant.

CPE 117

Regulator for electric heating apparatus

The *Electrotap* is a unit operating on the well-known energy regulator principle providing continuous regulation of the power consumption of any electrical heating apparatus in a range from zero to about 60% of its full load. It is inserted in series between the main and the apparatus and can be suspended at any place in the vicinity of an existing wall socket, thus saving the expense of a special wiring installation.

The makers state that the unit compensates for fluctuations in the electrical supply and possibly harmful changes in the heating input which could reduce the quality of the material being heated. In many cases, it is stated, it replaces automatic temperature control, and it regulates energy input down to the smallest of values of thermo diffusion.

The *Electrotap* is the size of a normal switch-socket combination. The pilot unit housed in a white plastic case, consists of a heated bimetal strip mounted with three screws on a base plate. The pilot switching unit is actuated by means of a control knob causing the bimetal strip to change its relative position to the tripping point of the leaf spring, enabling a continuous regulation of the switching cycle. In this way, it is claimed, continuous regulation of the heating apparatus is achieved.

The unit is available in two types, each costing £5 5s.

CPE 118

SHOT-CLEANING SYSTEM FOR BOILER SURFACES

A new shot-cleaning system is stated to be a highly effective means of cleaning boiler horizontal tube surfaces (*e.g.* air heaters, economisers, etc.) where the flue-gas temperature does not exceed the ash-fusion temperature. Operational costs are less than 10% of those for an equivalent soot blower installation, and operation involves no loss of condensate.

Small, irregularly-shaped metal shot is cascaded evenly from a distributor above the tube banks through which it is dispersed by gravity and the velocity of the furnace gases, thus dislodging the deposits in the early stage of their formation.

The shot and deposit fall towards an inclined-screen separator where a controlled current of air returns the heavy deposit to the gas stream, while allowing the shot to fall into a collector bin, from which it is returned to the distributor either pneumatically or by a mechanical conveyor.

The frequency of the operation depends on such factors as boiler loading and nature of deposit. A typical cycle might involve operation every 8 hr.

CPE 119

These examples of aircraft ducting, produced by Aeroplastics Ltd. from Bakelite *polyester resins reinforced with glass fibre, give some idea of the adaptability of the materials. They are light in weight yet extremely strong, and cannot corrode.* **CPE 120**

Diamines for curing epoxy resins

The use of aliphatic diamines as cross-linking agents for epoxy resins is the subject of a recent technical bulletin.

The *Duomeens* are a series of diamines of the general formula $R.NH.C_3H_6NH_2$ where R represents an alkyl group derived from fatty acids. In *Duomeen T*, for instance, the alkyl group is derived from tallow and in *Duomeen S* from soya fatty acids. The *Duomeens* are pale, paste-like materials with melting points ranging from 20 to 48°C.

In a typical example described in the bulletin, *Duomeen S* is used with an epoxy resin at the rate of 69 parts *Duomeen S* to 100 parts resin. Mixing at 50° is recommended, and pot-lives ranging from 120 min. at an ambient temperature of 25°C. to 30 min. at 75° are claimed. Post-curing at 150°C. will not affect the flexibility of the system, it is stated.

The flexibility of an unmodified epoxy/*Duomeen S* system is compared with that of plasticised vinyl polymers. Greater resistance to thermal shock and mechanical vibration is claimed, and it is also stated that the resilience and flexibility of the system coupled with its excellent electrical properties make it particularly suitable for the embedment of electronic parts.

CPE 121

New Books

Cost Estimation for Chemical Engineers

British chemical engineers will envy their American colleagues the wealth of cost data contained in this book.* Its 10 chapters include 88 graphs showing the cost of many kinds of process equipment and auxiliaries, together with numerous tables of unit costs and cost factors. About half of the book is devoted to capital costs and half to manufacturing costs. With this volume in his handbag a sales engineer in a hotel bedroom in South America could work out preliminary cost estimates for a complete factory. That is often the way to get business.

The sources of this mass of data are entirely American. Amongst the 220 references quoted there does not appear a single work published outside the U.S. There is no easy way of translating American costs into their European equivalents, and hence British readers will be less interested in the actual figures than in general trends and methods of correlation that they can apply to their own data. For example, the numerous graphs of equipment cost *versus* capacity are all log-log plots, and it is noticeable that more than half of them are curved. This means that in these cases the commonly assumed power relation between capacity and cost does not hold. On p. 161 there is an ingenious general correlation of man-hour requirements of process plants in terms of daily output and number of unit operations. It would be interesting to test this method of correlation for British conditions. The equation of p. 164 for estimating maintenance costs from power consumption is also worth a trial.

The various methods of preparing and presenting estimates of capital and manufacturing cost are clearly explained. Useful tables of items to be included help to prevent the commonest of estimating sins, that of omission. Economic facts are often presented in the form of equations and, if some of these appear trivial (*e.g.* the equation on p. 191 showing that profit equals sales price less manufacturing and other costs), they are at least plain.

One small matter of words: on p. 194 and elsewhere there are several references to 'per cent. . . . expressed as a decimal.' One generally expresses a ratio as *either* a percentage *or* a decimal.

The principal criticism of the book as a whole is that, although the subject matter is based upon statistical data, there is an almost complete absence of the statistical approach. For example, each of the cost graphs was presumably derived from a particular set of prices. It should therefore have been possible to calculate confidence limits showing how closely these prices conformed to the mean curve, and what order of deviation might be expected. The preparation of a cost estimate *per se* is only the first step in the job of estimation. The next step is to estimate the reliability of the the estimate and, at present, this has to be guessed. When the methods of statistical analysis are systematically applied to cost data we may see the beginnings of a science of cost estimation. Until then all works on the subject must remain at the level of rule-of-thumb compilations, useful mainly in the country to which their data apply. Of such compilations the present volume is, in the reviewer's opinion, the best that has yet appeared.

R. EDGEWORTH JOHNSTONE

*'Chemical Engineering Cost Estimation,' by Robert S. Aries and Robert D. Newton. McGraw-Hill Book Co. Inc., 1955. Pp. 276, \$6.

Liquid-Liquid Extraction

This book,* the first to stress the practical aspects of the subject, will be welcomed by chemists and chemical engineers interested in liquid-liquid extraction. It does not cover quite the same ground as two other books on the subject (Treybal: 'Liquid Extraction'; and Sherwood and Pigford: 'Absorption and Extraction').

The first two chapters are devoted to the liquid-liquid phase equilibria and its diagrammatic representation. A detailed description then follows, both of theory and practice of the major extraction procedures, namely cross-current extraction, countercurrent extraction, two solvent extractions and reflux in extraction processes. The subject matter is developed in all cases starting from first principles and can, for the most part, be followed without previous knowledge of the subject. Several solved practical examples illustrate the various extraction calculations. The techniques of measurement of experimental data for liquid-liquid extraction are fully described. Hitherto unpublished equilibrium data for the two ternary systems, aniline-*n* heptane-toluene and furfural-xylene-*n* hexadecane, are also included.

No attempt is made to cover fully the details of construction and operation of extraction towers, and only the packed and the perforated plate towers are briefly discussed. In a practical book of this type it would have been desirable to include methods for the estimation of pressure drop and capacity of extraction towers.

The book appears to be relatively free from errors and misprints, but one or two points were noted by the reviewer at a casual glance. For instance, Fig. 38 on p. 57 does not seem to indicate the system the data refers to, while the opening remark on p. 88, 'In countercurrent extraction . . . feed and solvent are introduced continuously to the top and bottom of the tower respectively . . .' is obviously incorrect, for, as pointed out later on, the arrangement will have to be reversed if solvent is heavier of the two.

The book is well produced and reasonably priced. O. P. KHARBANDA

*'Liquid-Liquid Extraction — Theory and Laboratory Experiments,' by L. Alders. Cleaver-Hume Press Ltd., 1955. Pp. 206 inc. index, 32s.

Valves, controllers, etc. Over 30 years ago, when the great potentialities of the diaphragm- and lever-operated valves were realised and the principle demand was for a valve that would shut 'steam tight,' British Arca Regulators Ltd. evolved their single-seated, balanced and ported valve. The design has been modified and extended to keep abreast of modern engineering developments, and the company state that it is now available in all appropriate sizes and for the highest temperatures and pressures. The range of valves is described and illustrated in an 18-page publication (No. 0039) which also includes information on controllers, oil pump sets, servo-motors and desuperheaters.

Chemical products. From the early days of the company's long history in the refining and working of the precious metals the chemical compounds of these elements have been among the products of Johnson, Matthey & Co. Ltd. In more recent years an extensive range of compounds of the minor and rarer metals and of the oxides of the rare-earth elements has been added. All these are listed in newly issued publication 1750, 'Chemical Products,' which supersedes publication 31.

Fire in a Chemical Works

GRIM LESSON OF ATTRITOR HOUSE DISASTER

The particularly dangerous nature of a flash fire was vividly demonstrated by an incident at the works of John & James White Ltd., chemical manufacturers, in Glasgow recently. The fire brigade was called to a fire which caused little damage and no casualties, but after this had been extinguished a second fire followed in which nine works employees were killed and two others were badly burned. Seven firemen were seriously burned and two slightly burned. The part of the building where the fire occurred was wrecked. It is in the hope that wide publication of the circumstances may help to avert similar disasters in future, and also underline the need for constant vigilance against fire in the chemical and allied industries generally, that we publish the accompanying details of the fires, followed by some remarks on the installation of pulverising plant generally.

Construction and layout of premises

THE fires occurred in the attritor house, containing coal pulverising plant. The plant supplied fuel to rotary kilns used for the processing of chemicals in the adjoining furnace shop.

The attritor house was of one storey 30 × 27 ft. and 40 ft. high with a number of metal and timber platforms. It was of steel-framed construction with walls of brick to a height of 20 ft. and of asbestos cement sheeting for a further 15 ft. The floor was of earth. In the floor were ducts covered by clay tiles over which was placed metal sheeting. The roof was of corrugated asbestos-cement sheeting on timber trusses. There were openings in the wall between the attritor house and the furnace shop through which feed pipes passed from a hopper in the former to kilns in the latter.

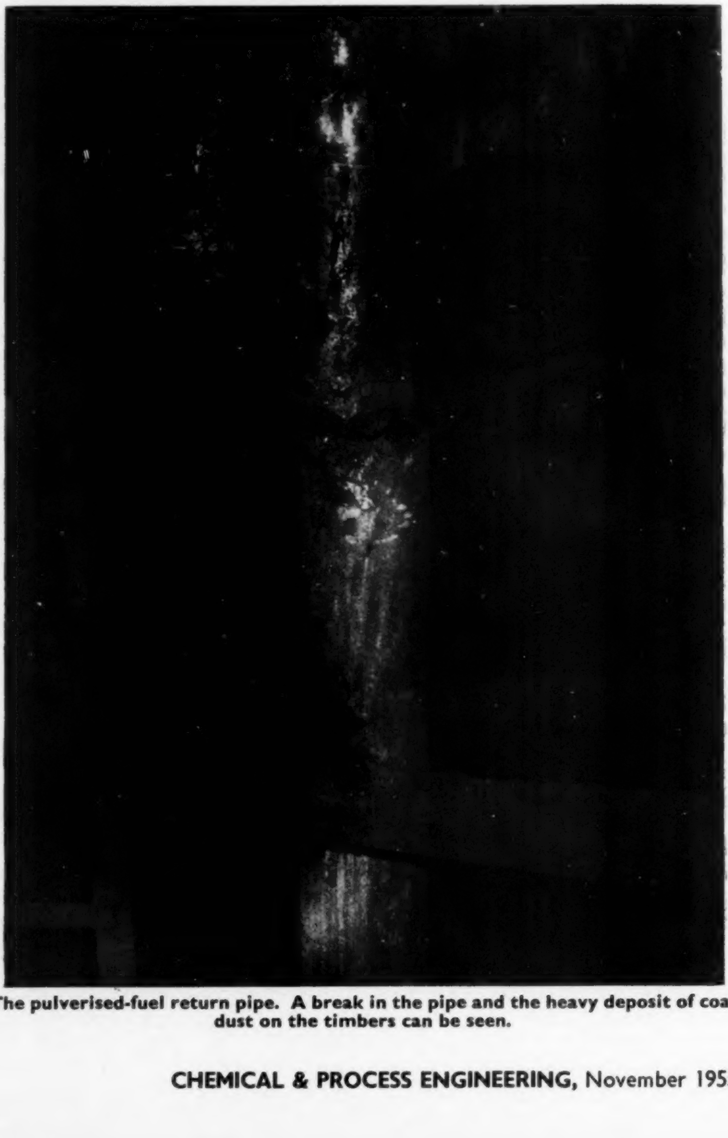
The attritor house contained two pulverisers in which coal was ground while being heated by flue gases supplied through the ducts in the floor, from solid-fuel furnaces in the furnace shop. The heated and pulverised coal was then blown by fans to a cyclone from which it was fed by gravity into the hopper beneath, whence it was conveyed by worm conveyors to the feed pipes and forced by fans to the kilns. One of the main feed pipes was so constructed that unused fuel could be returned to the cyclone. A large-diameter vent pipe led from the cyclone through the roof to a height of about 10 ft. above the roof ridge. The outlet to this vent pipe was fitted with a baffle plate.

The whole of the attritor house and its contents were coated with an accumulation of coal dust which was 6 to 12 in. deep in parts. Employees were removing this layer from the upper staging during the early stages of the first fire. The work was suspended when the fire brigade arrived.

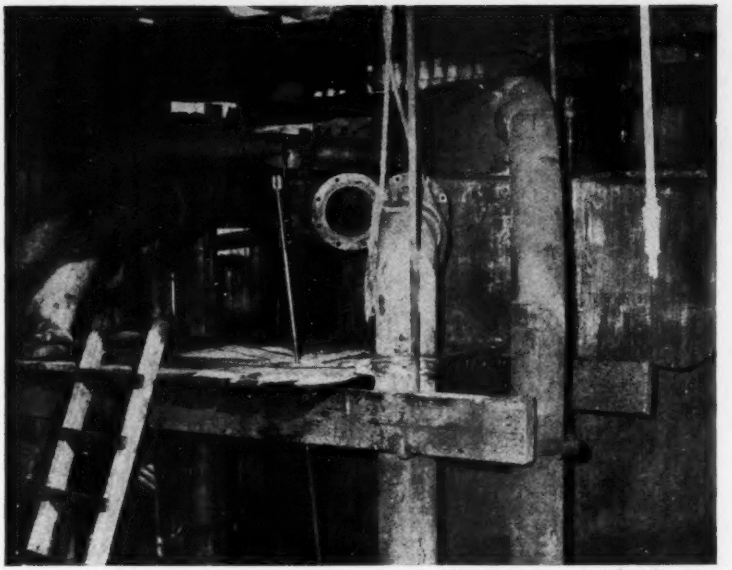
The electric lighting was not of a flameproof construction.

How the fires started

The first fire started at about 11 a.m. when coal dust lying on the floor ducts of the attritor house ignited. This fire spread to pulverised fuel in one of the pulverisers and thence to the cyclone. Sparks escaping from the cyclone vent pipe set fire to coal dust deposits on the roof and to the roof timber itself. The fire brigade was



The pulverised-fuel return pipe. A break in the pipe and the heavy deposit of coal dust on the timbers can be seen.



[Photos, courtesy Lanarkshire Fire Brigade

A timber platform showing pipe connections from the pulverisers to the top of the cyclone. Here, two bodies were found.

called at 6.36 p.m. and on arrival quickly extinguished the small fire on the roof.

After this fire had been extinguished the works manager reported that the side of the cyclone hopper was warm. It was suspected that the pulverised fuel in the hopper was on fire and it was decided to empty it. After one or two barrow loads of fuel had been removed it was found that the fuel, although warm, was not glowing and showed no sign of fire, so the emptying of the hopper was suspended and the clearing of the accumulation of coal dust from the upper staging was resumed by the works manager and four men.

While this work was in progress the atmosphere was so dense with coal dust that from time to time the electric lights were completely obscured, giving the impression that they had been put out. The fire brigade had hosed down the floor of the attritor house and was standing by in case its services should be required.

About 45 min. later, while this operation was still in progress, the second fire occurred, enveloping the building instantaneously in a burst of flame.

Possible causes of the fires

The first fire was caused by overheating in the ducts under the earth floor of the attritor house, resulting in the ignition of deposits of coal dust on top of the metal plates covering the ducting.

There were a large number of possible causes of the second fire:

(1) The electrical installation was live during the removal of the coal dust. Furthermore, a number of lighted electric light bulbs were broken by falling lumps of coalesced dust. The dust may have been ignited by an electric spark.

(2) A smouldering ember left from the first fire may have been concealed in the dust on the upper platforms and on being shovelled down may have burst into flame.

(3) (*a*) There were a number of holes in the fuel return pipe which connected the top of the cyclone with the fan blowing fuel to the kiln. It was later found that fuel had been burning in this pipe.

(*b*) A rubber washer on the flange joining this pipe to the fan was partly burned from the inside, leaving an opening. A wooden distance piece in the flange on the opposite side of the fan casing was in a similar state.

(4) Throughout the incident sparks were issuing from the cyclone air vent. One of these may have found its way through a space in the roof.

(5) The ducts in the floor were still very hot from the first fire.

(6) Steel shovels were used to remove the coal dust from metal platforms and may have caused sparks capable of igniting the dust.

Casualties and damage

Of the nine employees killed, five were in the attritor house. Three of the five men in the attritor house were on the upper staging and were killed outright; two were on the ground floor and were so severely burned that they died in hospital. The four other employees who were killed were outside the attritor house standing beside the firemen some yards from the west door.

The works' employees standing with the firemen died from their burns, but the firemen, although severely burned, recovered in hospital. The works' employees were wearing ordinary dungarees, while the firemen were wearing cork helmets and heavy tunics.

There is no doubt that the clothing of the firemen saved their lives.

The flash is reported by witnesses to have burst from all openings in the building to a distance of about 60 ft. This is confirmed by an examination of the damage outside the attritor house. A timber cupboard 60-ft. away was destroyed and roofing of the furnace shop within 60 ft. of the flash and the paintwork of a fire appliance 20-ft. distant were badly scorched.

In the attritor house itself, timber platforms, sections of asbestos sheeting and over half of the roof trusses were damaged.

Some rules for pulverised fuel systems

Pulverising plant should be installed in a well-lit building, the interior of which is as free as possible from ledges so that dust cannot collect. It should be kept clean and free from accumulations of dust.

All parts of the plant should be securely enclosed and all joints should be dust-tight, so that no dust is distributed from the process.

The ducting and the pulverising mill should be so constructed that they will withstand the pressure of an internal explosion. To provide a safety margin, the initial thickness of metal should allow for substantial wear due to the friction of the coal dust. If the fuel is dried artificially, the heating should be controlled so that there is no risk of ignition of the coal in the drier.

An efficient magnetic separator should be fitted to prevent iron articles from reaching the pulverising mill, since sparking in a mill is almost sure to cause an explosion.

Where a furnace is fed direct from the pulverising mill there is little chance for dust to collect, but where a storage hopper is interposed, there may be a risk of explosion.

The inside of the hopper should be smooth and free from ledges. The

inlet pipe should be so placed that a minimum of dust is formed in filling the bin, and a reliable indicator should be provided to prevent over-filling.

Explosions occur in the furnace to which the pulverised fuel is supplied and it is important that operating personnel should be acquainted with the dangers of lighting the burner incorrectly.

The furnace should be purged with air for some minutes before fuel is admitted. The pilot burner must be alight and, if ignition of the pulverised fuel does not occur within a few seconds, the supply should be shut down and the furnace purged again.

A common cause of explosions is the presence of a naked light in the furnace before the system is purged. Only a very small source of ignition, such as a match, is required. Even air flowing over a particle of hot soot may cause ignition.

In addition to the foregoing, the following extract from 'The Efficient Use of Fuel' (H.M.S.O., 1944), page 254, is of interest:

'It is thoroughly sound practice to install pulverising equipment with white-washed walls and floors, and the house should be well illuminated. In this way it is readily possible to detect dirt. A well-kept plant is likely to involve low maintenance costs, but if the pulverising plant is installed in a dark and dingy hole with little illumination, the plant is not so likely to be well looked after, and small faults such as leaks are not detected before they multiply and bring a train of other troubles in their path.'

Acknowledgment

Grateful acknowledgment is made to the Fire Protection Association for enabling us to publish the information contained in this article.

British Patent Claims

The following are abstracts of some recent British patents which will be of interest to our readers. These abstracts are reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

Pulverisation of liquids

Liquid is pulverised by disposing in a flow of a gas a wing of substantially symmetrical profile and by providing, in the zone of depression formed near the leading edge of the wing, jets of the liquid which collide and constitute a liquid disc submitted to the depression and to the high-speed flow of gas existing in the zone. The liquid disc is thus disintegrated into minute particles which are carried away by the flow of gas towards a zone of turbulence following the zone, final pulverisation being realised in this zone. —736,210, *Sebac Nouvelle Soc. Anon.* (*Switzerland*).

Heat exchangers

A hollow body has first passage for one heat-exchange medium disposed transversely of second passages for the other heat-exchange medium, the first and second passages being formed in sets. Each set consists of at least several holes formed by boring through the body, and each set of first passages is disposed between two adjacent sets of second passages, the latter extending from the interior to the exterior of the hollow body.—736,305, *Soc. le Carbone-Lorraine* (*France*).

Magnetic separator

A magnetic separator for separating magnetisable materials from liquid, dust, gas, etc., comprises a roller mounted on a shaft of magnetic material and energised by permanent magnets so as to have the same polarity throughout its surface, and a casing which surrounds and is spaced from the roller and is in magnetic contact with the shaft so as to form between the roller and the casing a substantially uniform magnetic field through which the material to be separated is passed. —736,332, *H. Spodig* (*Germany*).

Fluid-flow control valves

A glandless valve (*e.g.* for controlling toxic and reactive materials, and especially liquid metal such as sodium or sodium-potassium alloy) comprises a body having two ports, an arm pivoted between its ends within the body, a gate member carried by one end of the arm for lateral movement into and out of position between the ports, and a flexible metal bellows secured at one end around an opening in the body (through which the arm is operated) and at the other end to a point on the arm between the gate member so as to contain the pivot.—736,435, *United Kingdom Atomic Energy Authority*.

Phosphorus recovery

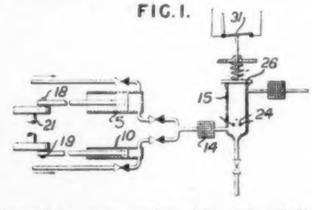
A continuous method for separating phosphorus from a hot gaseous mixture containing phosphorus oxides, hydrogen fluoride and silicon tetrafluoride comprises continuously contacting the mixture with an aqueous solution containing ammonia, separating uncondensed gases from the resulting condensed phosphorus, sludge and ammoniacal solution, separating the phosphorus and sludge from the ammoniacal solution, adding ammonia to the ammoniacal solution to raise its pH to at least 5 either prior to or after separating the phosphorus and sludge, and contacting the resulting ammoniacal solution with further gaseous mixture.—736,534, *Monsanto Chemical Co.* (*U.S.*).

Gas testing

The approach to explosibility of a combustible gas, due to the presence of oxygen or air therein, is tested by adding to the gas a predetermined proportion of air and leading a sample of the resulting mixture into an explosion chamber. The charge, when stationary in the explosion chamber, is subjected to the action of an ignition device. Any resulting explosion may be used to switch off an electrostatic precipitator used in purification of the gas.

As shown, pumps 5, 10 operated by a coupled power drive 21 through

FIG. 1.



adjustable eccentrics 18, 19, deliver gas and air respectively *via* a flame trap 14 to explosion chamber 15 where the mixture is subjected to a spark between electrodes 24. An explosion raises cap 26 and opens switch 31 in the control circuit of the electrostatic precipitator.

A flexible diaphragm may replace the cap 26. Pumps giving a continuous flow may be used in place of the pumps 5, 10, in which case intermittent supply to the explosion chamber is effected by a diversion valve operated by timing gear.

In an alternative arrangement, a constant sub-atmospheric pressure is maintained on the delivery side of a rotary pump by means of a governor-regulated valve in the gas supply line, and air is admitted through a calibrated orifice plate; two explosion chambers which operate alternately are provided.—692,712, *North Thames Gas Board*.

World News

Mr. Butler Praises Chemical Industry

Chancellor of the Exchequer at A.B.C.M. annual dinner

That the chemical industry could give a lead to industry generally in helping to stem the tide of inflation was suggested by the Chancellor of the Exchequer, Mr. R. A. Butler, at the annual dinner of the Association of British Chemical Manufacturers. He pointed out that much of the chemical industry's export drive is indirect in that the industry supplied the materials for other export industries to work upon. He added: 'The movement of your prices, therefore, touches our export business at many points; by cutting costs you can help over a wide field. The wholesale cost of your output has on the average, I believe, risen less in recent years than in manufacturing generally. Perhaps you can do still better.'

Mr. Butler's speech was full of praise for the accomplishments of the chemical industry. The industry, he pointed out, was today so vigorous and versatile that it was impossible to define it. That, perhaps, was one of the marks of greatness.

Mr. Butler was replying to a toast of 'The Guests' proposed by Mr. W. J. Worboys, chairman of the Association. Mr. Worboys spoke about important changes that were to be made in the organisational structure of the A.B.C.M., abandoning the 'group' structure and creating in its stead a number of regional committees. He also spoke of the need for the exchange of non-confidential information between firms and pointed out that such exchange could speed up the rate of growth of the companies and of the industry.

One of the main topics of Mr. Worboys' speech was chemical engineering research, also referred to in his speech (reported on another page) at the annual general meeting.

A.B.C.M. elections. The following will serve as officers of the Association during 1955-56:

President, Sir Graham Hayman; *vice-presidents*, Dr. F. H. Carr, C.B.E., Sir Roger Duncalfe, Dr. E. V. Evans, O.B.E., Sir Harry Jephcott, Mr. C. F. Merriam, M.C., Mr. L. P. O'Brien, Mr. W. J. Worboys; *honorary vice-presidents*, Mr. C. E. Cary, Mr. N. N. Holden and Lord McGowan, K.B.E.

Chairman, Mr. G. F. Williams; *vice-chairman*, Mr. B. Hickson; *honorary treasurer*, Mr. J. L. Harvey, M.B.E.

GREAT BRITAIN

Centenary of synthetic dyestuffs discovery

In 1856, William Henry Perkin, then aged 18, discovered the first synthetic dyestuff, later called 'mauve,' and from this discovery have developed the modern dyestuffs industry and the greater part of the world's organic chemical industries.

Thus the basic discovery made by this young Englishman 100 years ago inspired the present-day pharmaceutical industry, synthetic fibres and plastics, pigments and resins for the paint trade and other industries well recognised today as essential to modern life.

The Society of Dyers and Colourists decided some time ago to inaugurate plans for the celebration of the centenary of Perkin's discovery. Other learned and scientific bodies have now joined the Society and fully detailed plans are being prepared.

The main centenary celebration will be held in London during early May 1956 and will take the form of a series of five lectures dealing with the effects of Perkin's discovery on life and industry during the past 100 years. There will also be a conversazione and a banquet.

British Oxygen subsidiary

The British Oxygen Co. Ltd. have announced that their Chemicals Division is being brought under a new subsidiary company which will be known as British Oxygen Chemicals Ltd.

The objects of the new company are to manufacture and sell chemical derivatives of carbide of calcium, acetylene, nitrogen, oxygen, etc. The authorised capital is £1½ million, which will be divided into 1½ million shares of £1 each. The directors are Mr. F. C. S. L. Lewin-Harris and Dr. R. F. Goldstein.

Change of name

The name of the India Rubber, Gutta Percha & Telegraph Works Co. Ltd. has been changed to Silvertown Rubber Co. Ltd. and all the company's operations and business will be carried on under the new name. In announcing this the company state that the change will in no way affect any obligations previously entered into by the company.

The company, which was formed in 1864 to take over the West Ham works of S. W. Silver & Co., was originally registered as Silver's India Rubber Works & Telegraph Cable Co. Ltd., and the neighbourhood acquired its name Silvertown from the presence of the factory and the dwellings of its employees. The company has for very many years used *Silvertown* as its general trade mark and has for long been known as the Silvertown Co.

The Silvertown factory has been responsible for many innovations now standard practice in the rubber industry. Progressively modernised, it remains the company's principal manufacturing unit.

Hydrogen from propane

The Power-Gas Corporation Ltd., of Stockton-on-Tees, has announced the receipt of an order from Unilever Ltd. for the production of high-purity hydrogen from propane, using the Hercules re-forming process.

The plant, which will be capable of producing between 16,000 and 22,000 cu.ft./hr. of hydrogen, will consist of a re-forming furnace, followed by two stages of CO conversion and CO_2 removal and methanation and, in addition, hydrogen compressors, propane and high-pressure hydrogen storage equipment and a Wiggins' gasholder of 7,500-cu.ft. capacity. The hydrogen will be used for hardening edible oils at the Purfleet works of Van den Berghs & Jurgens Ltd.

Oil gasification plant

The Scottish Gas Board is to erect its first catalytic oil gasification plant at Dundee, producing from oil a gas to supplement existing coal-gas sources. At a gathering in Dundee it was revealed by Mr. W. S. Johnston, Dundee group manager, Scottish Gas Board, that the final plans were in process of completion. It is hoped to have the plant operating within the next two years, and to secure a daily output in the region of 3 million cu. ft.

New company

Head, Wrightson & Co. Ltd. announce the formation of the Head Wrightson Export Co. Ltd. to extend their interests in markets overseas. Mr. Vaughan Pendred has been appointed managing director, with London headquarters at 20 Buckingham Gate, S.W.1.

Carbon black plant reorganised

The reorganisation of the carbon black plant of Amalgamated Anthracite Holdings Ltd. at Port Tennant was described by the chairman of the company at the annual general meeting as entirely successful. The reorganisation was stated to have 'provided a most efficient unit which is producing certain qualities of carbon black both efficiently and economically.'

The chairman stated: 'To get the best results from our investment further plant additions are vitally necessary to enable us to supply all the qualities of carbon black especially required in the tyre trade, who are the biggest users of carbon black and have an ever-increasing potential.'

Germanium rectifier

The first power germanium rectifier to be put into normal commercial service in this country was commissioned recently. The rectifier was manufactured by the British Thomson-Houston Co. Ltd. to the order of Imperial Chemical Industries Ltd.; it is rated 1,000 kw., 255 v. and 3,920 amp. It consists of two cubicles housing a series-parallel arrangement of air-cooled germanium rectifier cells connected to form a six-phase, full-wave bridge. The rectifier is supplied from an existing delta-diametric connected transformer which previously supplied a rotary convertor.

The British Thomson-Houston Co. is also supplying 10 mechanical contact rectifiers, each rated 3,300 to 4,050 kw., 220 to 270 v. and 15,000 amp., to I.C.I.

New address

Arising from the merger of Hordern-Richmond Ltd. with Permali Ltd. last year, new Manchester premises for both companies have now been opened at third floor, 'B' block, 89 Oxford Street, Manchester 1.

Change of telephone number

The telephone number of the head office and laboratories of Styrene Co-Polymers Ltd. has been changed to Sale (Manchester) 8256.

Institute of Metal Finishing

The Institute of Metal Finishing announces that the officers and council for Session 31 (1955-56) are: president, Mr. R. A. F. Hammond; immediate past president, Prof. J. W. Cuthbertson; vice-presidents, Dr. S. G. Clarke, Dr. T. P. Hoar, Dr. L. B. Hunt, Mr. R. W. Nicol, Mr. H. Silman, Mr. A. Smart and Mr. A. W. Wallbank; honorary treasurer, Mr. F. L. James; honorary secretary, Dr. S. Wernick.

Spanish engineers in Britain

A party of 13 Spanish engineers arrived by air recently to commence a six months' course of training with Metropolitan-Vickers Electrical Co. Ltd. This special arrangement follows the placing with Metropolitan-Vickers of a large contract for steam-power-station generating equipment for the Instituto Nacional de Industria. Commissioning of the equipment is planned for commencement in the early part of 1957 and the trainee engineers are being prepared for its operation in service.

B.S.I. in Birmingham

The British Standards Institution has opened a sales office in the headquarters of the Birmingham Chamber of Commerce at 95 New Street, Birmingham 2.

Corrosion-resistant lining and covering of chemical plant

Redferns (Bredbury) Ltd., a subsidiary company of Redfern's Rubber Works Ltd., of Hyde, Cheshire, has now commenced trading as a separate entity.

★ Personal Paragraphs ★

★ **Sir Eric Bourne Bentinck Speed,** K.C.B., K.B.E., M.C., has been appointed to the British board of Engelhard Industries Ltd. He has had a distinguished career in the Civil Service and in 1942 was appointed Permanent Under Secretary of State for War, a position he held until he retired from the Civil Service in December 1948. In 1949, he became first managing director of the Anglo-Australian Corporation of Melbourne and Sydney, Australia, and remained in this office until his recent return to the U.K. In the United Kingdom, Engelhard Industries has three main divisions: the Hanovia Lamps Division; Baker Platinum Division; and Hanovia Products, which is their Ceramics Division.

★ **Mr. T. P. Berington** has been elected vice-chairman of Monsanto Chemicals Ltd. He joined Monsanto in May 1929 and was appointed to the board of directors in March 1930.

★ **Sir John Wrightson,** BT., and Mr. P. Wrightson have been appointed managing directors of Head, Wrightson & Co. Ltd. Mr. R. Miles is chairman and managing director; Sir John Wrightson, vice-chairman.

★ **Mr. G. A. Plummer** has been appointed to the main board of John Thompson Ltd. He is, and will continue as, a director and chief engineer of John Thompson Water Tube Boilers Ltd.

★ **Mr. S. H. Parker** has joined Teddington Industrial Equipment Ltd. as general manager. He was formerly general sales manager of Sunvic Ltd.

★ We regret to announce the sudden death of **Mr. Howard Evans,** superintendent of the research laboratory of the Mond Nickel Co. Ltd. at Birmingham. He has been associated with a wide variety of research projects in both the ferrous and non-ferrous fields.

★ **Dr. W. Steven** has been appointed superintendent of the Mond Nickel research laboratory at Birmingham in succession to the late Mr. Howard Evans. He joined the company in 1947 as a research metallurgist; in May 1954 he was appointed principal assistant to the superintendent.

★ **Mr. M. J. Smith** has been elected to the board of directors and appointed overseas trade director of Evans Medical Supplies Ltd.

★ **Mr. B. Watson,** who founded Expandite Ltd. 21 years ago and who has served as managing director since the company's inception, has been appointed chairman.

★ **Mr. J. Watson Napier,** of Fisons Ltd., has been elected president of the Fertiliser Manufacturers' Association for 1955-56, and Mr. P. K. Proctor (H. & T. Proctor Ltd.) has been elected vice-president.

★ **Mr. J. T. Proctor,** of Hy. Richardson & Co. (York) Ltd., has been elected chairman of the Superphosphate Manufacturers' Association Ltd.; Mr. T. Williams (Eaglescliffe Chemical Co.) has been elected vice-chairman.

★ **Mr. Brian N. Reavell,** managing director of the Kestner Evaporator & Engineering Co. Ltd., recently left for a business visit to the Far East and Australia. The company has supplied a variety of chemical plant to the Far East in recent years and it is proposed to extend their activities by the establishment of local agencies in suitable areas.

★ The board of directors of Petrochemicals Ltd., now a subsidiary of Shell Chemical Co. Ltd., has been reconstituted as follows: **Mr. W. F. Mitchell,** chairman; **Mr. L. H. Williams,** managing director; **Mr. F. H. Braybrook,** general manager; **F. Mackley, E. J. Barnsley** and **L. R. Batten.**

CANADA

Expansion in the heavy chemicals industry

Plans for a $9-million ammonia plant for Canadian Industries (1954) Ltd., of 200 tons/day capacity, and a 125-ton anhydrous ammonia plant of the Quebec Ammonia Co., near Montreal, and the doubling of the capacity of the 75-ton plant of Sherritt Gordon Mines, reflect the stimulus of all three categories of exports. Ammonia is increasingly used by the pulp and paper industry in the production of sulphite pulp; the smelting industry requires larger quantities of ammonia as the chemical leaching of base metal ores expands; and the chemical industry is developing the direct application of anhydrous ammonia as a fertiliser. The expansion of production of forest products in the west (four new pulp and paper mills are under construction in British Columbia and Alberta) provides a market for an $11-million chlorine-caustic plant at Vancouver scheduled for operation in 1957. The development of the uranium ores of the Blind River area in Ontario requires large tonnages of sulphuric acid for leaching, and Noranda Mines are to construct a plant using pyrites to produce 500 tons of acid, about 70 tons of elemental sulphur and about 350 tons of iron sinter daily.

New pesticides company

Amalgamation of the pesticides operations of Canadian Industries (1954) Ltd. and Chipman Chemicals Ltd., the largest manufacturers of pesticides in eastern and western Canada, respectively, will take place within the next few months, it was announced recently. The joint company will be known as Chipman Ltd.; 50% of the shares will be held by C.I.L. and 50% by Chipman. The new company will have four plants located at Buckingham (Quebec), Hamilton (Ontario), Winnipeg (Manitoba) and Moose Jaw (Saskatchewan).

Chipman Ltd. will have behind it the extensive research resources of Imperial Chemical Industries Ltd. and Plant Protection Ltd., both of the United Kingdom, and of Chipman Chemical Co. Inc., United States.

GERMANY

Petro-chemicals plant

The first West German plant for large-scale production of chemicals and plastics based on crude oil, Rheinische Olefinwerke GmbH., started operations recently.

Set up jointly by Badische Anilin und Soda Fabrik, of Ludwigshafen, and the German Shell company, the plant is producing polythene by processing refinery gas. The polythene is being used as raw material for the production of plastics by Badische Anilin, while ethyl benzole is also being produced.

A spokesman for the company said the initial production aimed at was 10,000 tons of polythene and 12,000 tons of ethyl benzole p.a.

Chemical exports figures

West Germany's exports of chemicals rose more slowly in the first half of this year than imports, though the country remains a large net exporter of chemicals. Figures just released by the Association of the West German Chemical Industry show that the value of exports increased by 18% to 1,630 million marks, compared with the same period in 1954, whereas imported chemicals, especially of semi-finished and finished products, increased by 35% to 570 million marks. The heavy demands of German industry were said to be the main cause of this upsurge in imports.

Most of the export increases went to markets outside Europe. Asian markets took chemicals worth 283 million marks or 15% of total exports, and North and Central America increased their purchases of German chemicals to almost 138 million marks. This rate of increase was not matched in exports to other European countries. But although Britain, which is one of West Germany's leading markets, took a much smaller share than formerly, total sales to European countries rose to nearly 1,000 million marks. A decline of about 20 million marks from January-June 1954 sales was recorded in exports to South America, particularly Brazil and Argentina, which fell to 100 million marks.

A new factory has been opened by the Alfa-Laval Co. Ltd. at Cwmbran, Mon. Here is a general view inside the workshop with assembled De Laval separators on the right.

SWEDEN

Big sulphate mill planned

Fiskeby Fabriks A.B., large kraft and wrapping paper manufacturers belonging to the Swedish Co-operative Union, have decided to build a new sulphate mill with an estimated capacity of 60,000 tons p.a. adjacent to the company's present plants at Skärblacka and Ljusfors in the province of Östergötland. The plant is to be completed within three years at a cost of nearly Kr. 60 million (£4,140,000). Most of the output of the new mill will be earmarked for export. The production of sulphate pulp at the Ljusfors plant has been successively increased from 25,000 to 45,000 tons during the past two years, and the combined output will thus exceed 100,000 tons when the new mill is in operation.

CUBA

Bagasse newsprint factory

The construction of Cuba's first bagasse newsprint factory has started at the Progresso sugar mill in the Cardenas Municiapality.

The plant will be built by Tecnicas Cubanas S.A.

FRANCE

Synthetic fibre combine

Leading French synthetic fibre producers have set up a new 10-million-francs company, 'Crylor,' to produce and trade textiles and other products based on polyacrylonitrile and any intermediary commodities.

PAKISTAN

Industrial development programme

As part of its 1955 aid to Pakistan the United States is to provide $300,000 towards the cost of six American industrial consultants who are to be attached to the planning board to assist in the preparation of an industrial development programme for inclusion in the five-year plan and to stimulate foreign investment in suitable industries in Pakistan. The consultants are specialists in industrial economics, chemical engineering, textile engineering, mechanical industrial engineering, food processes and refractory engineering.

RUSSIA

Rayon from fish meal

Fabrics made with viscose rayon fibre containing up to 20% of proteins obtained from whalemeat or fish refuse, have been evolved by the Russian All-Union Institute for Artificial Fibre Research, Moscow Radio reported recently.

The fabrics, which look and feel like wool, were stated to be superior in crease resistance and colour fastness to the usual wool viscose mixtures.

AUSTRALIA

Aluminium plant opened

The Australian Aluminium Production Commission's £A10-million (£8 million) plant at Bell Bay, Tasmania, was opened recently. The plant will produce about 6,000 tons of pure aluminium this year and possibly 10,000 tons in 1956. Its potential yearly output is 13,000 tons.

DOMINICAN REPUBLIC

Furfural from bagasse

A modern plant for the extraction of furfural from sugar-cane bagasse was opened at La Romana by Central Romana By-Products Inc. recently. The plant involved an investment of over R.D. $7 million, provided mainly from American sources. Various customs and tax exemption facilities were granted to the company by the Government for the import of machinery and for the use of fuel oil in lieu of bagasse, hitherto used for heating purposes in the sugar mills. Supplies of sulphuric acid used in the extraction process will also be obtained locally from Government sources.

E. I. Du Pont de Nemours have contracted to take 20 million kilos p.a. of furfural for 10 years for use in their new nylon factory in the United States.

The Leonard Hill Technical Group—November

Articles appearing in some of our associate journals this month include:

Petroleum—Special Kwinana Refinery Number: Process Units and Design; Construction and Erection Problems; Layout and Integration of Units and Services; Procurement of Equipment; Review of British Equipment Installed at Kwinana.

Corrosion Technology—Nickel Plating by Direct Chemical Deposition; Corrosion in Singapore; Corrosion Inhibitors in Petroleum Refinery Service.

Paint Manufacture—Evaluation of Aluminium Pigments; Making Glowing Colours; Resins from Petroleum; Use Your Plant Efficiently, 2; Problems of Paint Manufacture.

Food Manufacture—Garden Peas from a Midland Factory; The Dehydration of Carrots; Research at INACOL; Bakers' and Confectioners' Exhibition; Production of Crystallised Fruits; Removal of Oxygen in the Gas Packaging of Food; Mobile Laboratory for Danish Meat Factories; Food Technology at American Chemical Society Meeting.

Manufacturing Chemist—New Terramycin Plant at Sandwich; Vanillin; The Organic Acid Radical in Therapeutics; Adrenergic Inhibitors, 2: Pharmacology and Therapeutics; Medicinal Products from Tropical Plants; International Pharmaceutical Conference; Progress Reports on Pest Control Chemicals, Perfumery and Essential Oils, Disinfectants.

Fibres—Synthetic Filling Materials for Brushes; Courlene Polythene Yarn — Its Industrial Possibilities; Cellon—The New British Celanese Fibre.

Atomics—Nuclear Reactor Instrumentation; Gas Counting Techniques in Biochemistry, 1.

Dairy Engineering—Preview of the Dairy Show; The Cheeses of Great Britain, 12: Gloucester, Single and Double, and Cotswold; Manufacture of Milk Chocolate Crumb; Aluminium Churns in the Making; Paying for New Machines.

NETHERLANDS

Glycerol project

The first synthetic glycerol plant to be built outside the U.S. will be erected at Pernis refineries near Rotterdam by the Bataafsche Petroleum Maatschappij, B.P.M. The plant will cost about 25 million guilders and is expected to start operating in 1957.

The Shell Development Co. in California is at present operating one glycerol factory in California, while a second plant is under construction in America.

NORWAY

Mica production planned

With the aid of a loan from the North Norway Development Fund, the Rendalsvik Mineral Product Co. are to work the mica deposits at Meloy in Nordland. They hope to start production in the autumn with an output of about 4,000 tons p.a.

New chemical plant in production

At Glomfjord, north of the Arctic Circle, the Norwegian chemical concern Norsk Hydro has built a new plant for the production of 100,000 tons of complete fertiliser p.a. At Eidanger, in south Norway, Norsk Hydro is already producing complete fertiliser at the rate of 50,000 tons p.a. Complete fertiliser contains in highly concentrated form the three ingredients needed by the soil: nitrogen, phosphorus and potash.

Need for engineers

More Norwegian engineers are now being trained abroad than at Norway's own University of Technology at Trondheim, it was stated at a meeting of the Society of Engineers in Bergen. The University of Technology has an output of about 200 engineers a year, but Norway needs from 400 to 500 new qualified engineers a year. Norwegians are training as engineers at universities in Britain, the United States and elsewhere, and the estimated outlay in foreign currency is from £400,000 to £500,000 a year.

SPAIN

Cellulose project

It was recently reported that the State-controlled Instituto Nacional de Industria (National Institute of Industry) is to construct and operate a cellulose plant at Huelva in the south. The planned capacity is 20,000 tons of alpha cellulose or 24,000 tons of paper pulp.

IRAQ

Oil refinery removal envisaged

The oil refinery at Khanaqin which was to have been dismantled after the opening of the new Baghdad refinery may now be required in view of the steadily increasing consumption throughout the country. The Khanaqin refinery had a capacity of 18 million gal. of crude p.a. A U.K. consultant has recently completed investigations for a report on the practicability of moving the refinery to a new site, which would probably be in the Basra area.

JAPAN

Petro-chemicals project

The Maruzen Oil Co. is hoping to form a petro-chemical company by concluding a technical assistance contract with the Chemical Project Association of America; it is reported that a fee of $35,000 will be paid to the C.P.A. for technical assistance and $250,000 worth of American machinery for this project will be purchased through the C.P.A.

I.C.I. to assist chemical company

The Sumito Chemical Co. has announced that it has initialled a contract with Imperial Chemical Industries for 'technical assistance' in connection with the production of polyethylene. The company says it plans to build a 2,000-million-yen plant at Niihama, western Japan, reported to be capable of producing 5,000 tons of polythene p.a. and 85 tons/day of ammonia.

NORTHERN IRELAND

Prospect of wood pulping plant

Tests of timber grown in Northern Ireland are being made to determine its suitability for conversion into wood pulp for the manufacture of paper. The minimum quantity required to operate a wood pulping plant economically is 50,000 tons p.a. If that quantity of suitable timber is available in the next few years steps will be taken by the Government to establish a pulping industry.

ARGENTINA

Industrial events

Mining, etc. A contract worth 15,800,000 pesos for coal-washing plant with a capacity of 4,000 tons/day, destined for the Rio Turbio coal mines, has been awarded to the Czech concern, Techno-Export.

The Directorate of Military Factories is urging miners to increase production of manganese ore to meet the Directorate's demands, which are expected to rise to 10,000 tons p.a. by 1959-60.

The Export-Import Bank has advanced to the Eimco Corporation, U.S.A., the sum of U.S. $72,300, in respect of mining equipment which the corporation supplied to the National Lead Co. of Buenos Aires.

Argentine mining organisations have asked the Government to stop the import of precipitated calcium carbonate, since local production is now in excess of requirements.

Gas. A complete new gasworks with a capacity of 1 million cu.ft./day is to be built at Buenos Aires. Two smaller gasworks will also be built in Eva Peron and Bernal (Buenos Aires Province).

Oil. The capacity of the petroleum refinery at Lujan de Cuyo (Mendoza) is to be increased by almost double. There is sufficient crude extracted in the area to justify the extra capacity.

CHILE

Oil pipeline

Work is shortly to begin on the construction of the oil pipeline to Arica (Chile) which will have a pumping capacity of 50,000 bbl./day.

GREECE

Nitrate factory

The Minister of Co-ordination announced recently that the American Koppers Co. would shortly submit its design for the construction of a nitrate factory. Finance for the project has not yet been arranged and its realisation is therefore uncertain. The intention is for agricultural co-operatives and public utility organisations to co-operate eventually in the operation of the factory.

UNITED STATES

Helium plant projected

The U.S. Bureau of Mines will soon call for bids for the construction of a $6-million helium plant at Texas to increase the output of this lightweight, non-inflammable gas by 50%. With a rating of 100 million cu. ft. of helium p.a., the new plant would raise the Bureau's capacity to approximately 300 million cu. ft. The new installation will probably enable the Bureau to meet demands for helium until 1959 or 1960. After that, still another plant may be required.

Research on low-grade manganese ores

The U.S. Government's General Services Administration has announced a contract under which Ores Benefication Inc., of Joplin, Missouri, is to build a pilot plant to study a new process for treating low-grade manganese ores. The maximum costs the company may incur under the contract are $202,100, all of which will be underwritten by the Government.

The plant will be designed to handle 300 lb./hr. of slags and low-grade ores by a process developed by Bruce Williams Laboratories, also of Joplin.

Shell Chemicals plans expansion

The Shell Chemical Co. is planning the construction of two more chemical plants at Norco, Louisiana. The first would be designed to produce more than 30 million lb. p.a. of hydrogen peroxide; the second would consist of an acrolein unit and a plant designed to produce glycerine by a new process using hydrogen peroxide and acrolein. Recently Shell dedicated at Norco a new $8½-million allyl chloride and chlorohydrine plant.

'Wafer cell' battery

A new 'wafer cell' battery has been developed by the Burgess Battery Co. This is claimed to make possible a 30% increase in battery power and life, eliminate traditional hand operations from cell manufacturing, and raise cell productivity levels by substantial amounts.

The new cell consists of a sandwich of artificial manganese dioxide mix between tiny discs of flat zinc and carbon elements. The carbon rod of round cell batteries has been supplanted by a small piece of conductive carbon.

New synthetic rubber plant

The Firestone Tire & Rubber Co. has placed a contract with the Catalytic Construction Co. for the design and construction of a butadiene factory capable of producing 40,000 tons of synthetic rubber p.a. Firestone have recently approved plans to expand production at their Akron synthetic rubber factory by 35%. This is in addition to a 50% increase in production at the company's factory at Lake Charles, Louisiana, which will bring the company's total annual synthetic rubber capacity to more than 190,000 tons.

Cellulose project

The new chemical cellulose factory of Rayonier Inc. is to be built at Jesup, Georgia. The intention to build this plant was announced in Paris some months ago. The plant, which is part of the company's $80-million expansion scheme, will cost about $25 million. It is planned to start production in late 1957. It is to have a capacity of 100,000 tons p.a., which will bring Rayonier's production capacity of chemical cellulose to about 900,000 tons p.a.

Styrene monomer

The Cosden Petroleum Co. will start construction in the next few months of a $3-million plastic styrene monomer plant.

The plant, which will be built at the Big Spring Texas, refinery, will turn out an estimated 20 million lb. of plastic styrene monomer p.a. This will be used for the production of synthetic rubber.

MEETINGS

Institution of Chemical Engineers

November 9. 'Handling of Alcohols and Other Solvents,' by F. H. Walmsley, 6.30 p.m., The Midlands Institute, Birmingham.

November 15. 'An Assessment of Dry-blending Equipment,' by F. E. Adams and A. G. Baker, 5.30 p.m., The Geological Society, Burlington House, London, W.1.

November 16. 'Recent Developments in Pressure Vessel Construction,' by S. H. Griffiths, 7 p.m., The University, Leeds.

November 30. 'Combustion in Particulate Systems,' by L. Cohen, 7 p.m., College of Technology, Manchester.

December 6. 'Distillation of Liquid Hydrogen,' by Prof. E. S. Sellers and Dr. Augood, and 'Transient Behaviour of Plate Distillation Columns,' by J. F. Davidson, 5.30 p.m., The Geological Society, Burlington House, London, W.1.

December 6. 'The Impact of Industry on the Young Chemical Engineer,' by H. Fossett, 7 p.m., Grosvenor Hotel, Chester.

December 7. 'Phenolic Effluent Disposal,' by D. A. Hall, 7 p.m., The University, Leeds.

Institution of Mechanical Engineers

November 15. 'The Development of a Mechanical Draught Water-Cooling Tower,' by L. Gilling Smith and G. J. Williamson, 5.30 p.m., Institution of Civil Engineers, Great George Street, London, S.W.1.

November 18. 'Properties of Matter at High Pressures,' by Prof. D. M. Newitt, 5.30 p.m., 1 Birdcage Walk, London, S.W.1.

Institute of Fuel

November 23. 'Modern Industrial Dust Collection,' by C. J. Stairmand, 5.30 p.m., The Institution of Civil Engineers, Great George Street, London, S.W.1.

Chemical Society

November 10. 'Hydrogen-Transfer Reactions,' by Prof. E. A. Braude, 7.30 p.m., North British Station Hotel, Edinburgh. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry.

November 10. 'The Chromatography of Gases and Vapours,' by F. H. Pollard, 5 p.m., The University, Liverpool. Joint meeting with the R.I.C., the S.C.I. and the British Association of Chemists.

November 22. 'Preparation and Use of Radio Isotopes in Industry and Medicine,' by G. B. Cook, 7.15 p.m., The Queen's University, Belfast. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry.

December 1. 'Manufacture of Phosphoric Acid,' by J. J. Porter, 7 p.m., Chemistry Department, The University, Bristol. Joint meeting with the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals.

Society of Chemical Industry (Chemical Engineering Group)

November 14. 'A Theory of Drying Sheet Materials Using Heated Cylinders,' by A. H. Nissan, 7 p.m., Bradford Technical College.

Incorporated Plant Engineers

November 10. 'Steam for Process,' by L. G. Northcroft, O.B.E., 7.15 p.m., Royal Institution, Colquitt Street, Liverpool.

A Reaction Vessel Problem Solved

Simplicity is the principal feature of a new 4,500-gal. reactor for the production of styrenated alkyd resins at the works of Styrene Co-Polymers Ltd., which is reported to have proved very successful in operation. Conventional-type reactors of 1,450-gal. capacity had previously been used, and the company's first objective was the installation of a vessel identical in design and behaviour to those already installed but some three times greater in capacity. However, it was soon apparent that problems of heat transfer and agitation in a vessel of this size would inevitably necessitate some changes in design.

As a result of discussions with the company's consulting engineers, a radical alteration of design was submitted—a vessel with no mechanical stirrer and no built-in heating unit. In other words, an ordinary horizontal tank, built of stainless steel. It would be fitted with a pipe line through which the contents of the tank could flow from a bottom outlet through a pump to an external heat exchanger and return to the tank via injection nozzles. Agitation of the reactants would be obtained by circulation through the pump ejectors; heating would be obtained from the external tubular heat exchanger in which the heating medium could be either *Petrotherm* from an existing furnace or high-pressure steam; simplicity of design would lead to low capital cost.

The operative advantages of such a system were obvious. The same pump which circulated the contents for agitation could be used for charging and discharging the vessel. Viscosity and temperature control, by means of instruments installed in the pipe lines, would be simple. So, too, would sampling. Reactions under pressure or distillation under vacuum could be carried out. Additional reactants could easily be added in the pipe stream during the reaction, whether carried our under pressure or vacuum, without opening the vessel.

In 1952 a prototype to this design, of 1,450-gal. capacity, was quickly built and put into operation. It gave successful production of the whole range of styrenated alkyds, and in 1954 the larger reactor—a tank measuring $17\frac{1}{2}$ ft. by $7\frac{1}{2}$ ft. diameter—was installed. This has produced, and is continuing to produce, every member of Styrene Co-Polymers' range of styrenated alkyd resins and styrenated oil, and the company's news sheet reports that although production is not yet at 'full steam ahead' its performance has exceeded all expectations.

The reactor will be fitted with auto-selective control, enabling the contents to be heated up and automatically maintained at a given temperature. Safety devices will also be incorporated so that if recirculation should be reduced or stopped for any reason, the heat input will be shut off, and visible and audible warning given.

Ion-exchange materials. Recent work in the field of ion exchange has been in the development of highly basic acid absorbing resins which, when used in conjunction with a cation exchange material, not only remove strong acids but also weak acids. Thus a method is available for the removal of silica and the last traces of carbon dioxide from waters, in addition to the strong acids released in the cation exchanger, resulting in a treated water which is virtually free from ionic constituents. *Rezanex* (HB), states a 20-page illustrated brochure from Joseph Crosfield & Sons Ltd., is a highly basic resin of this type. It is further stated that, when this resin is used in conjunction with the company's carbonaceous cation-exchange material *Soucol*, it is possible to obtain a finally treated water of extremely high quality. The brochure (Technical Publication No. 32) contains operational data for *Rezanex* (HB) and a general indication is given of its characteristics and method of application.